MEASURES DEVELOPMENT STANDARD OPERATING PROCEDURE (SOP)

Version 2

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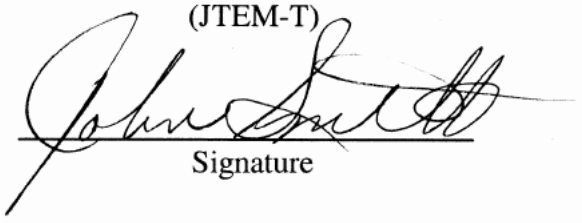

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Foreword

On September 15, 2010, the Director, JTEM-T, released the first version of the *Measures Development Standard Operating Procedure (SOP)*. That document described a process to facilitate development of mission and task-based measures intended for use in the evaluation of a system's impact on the performance of a system-of-systems.

This new *Measures Development Standard Operating Procedure (SOP), Version 2*, adds chapter 4, System and System-of-Systems (SoS) Measures Development, which describes system and system-of-systems measures development and shows the linkages that trace system impacts on task performance and mission effectiveness. The addition of this chapter provides the user an end-to-end process that demonstrates measures development and traceability from mission to task and to system.

The SOP is a guide. The information contained within comes from current authoritative sources and best practices and conforms to current military doctrine and statutory requirements. While this SOP is not directive or prescriptive, it captures important terms and concepts from the Joint Capabilities Integration and Development System (JCIDS), the Department of Defense (DoD) acquisition process, joint publications, and other sources that support mission-based test design. As a guide, this SOP:

- Assists in the assessment of the operational effectiveness and operational suitability of a system based upon its use to accomplish combat missions
- Traces the impact of a system on task performance and mission effectiveness
- Identifies relevant system and system-of-systems inputs and outputs that will help assess system contribution to the system-of-systems functional performance parameters
- Provides a disciplined and repeatable process for mission and task decomposition

If applied, the SOP measures decomposition process can help to 1) enhance testing processes for measuring and evaluating system impact on the system-of-systems using mission and task-based measures; 2) identify task and mission attributes and measures with traceability to warfighter requirements; 3) enable a quantitative vice a qualitative assessment of a system's impact on combat mission effectiveness; and 4) confirm that an identified capability gap has been successfully addressed.

An electronic version of this SOP is available on the unclassified Defense Acquisition University (DAU) Acquisition Community Connection web site at https://acc.dau.mil/TIJE.

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CHAPTER 1
MEASURES DEVELOPMENT BASICS

INTRODUCTION

This SOP facilitates development of mission and task measures and then integrates system/ system-of-systems (SoS) attributes and measures into the framework to provide a complete system to mission set of measures that can be used to assess a system's impact on SoS functions, task performance, and mission effectiveness. In this document, SoS is used as defined by the Joint Capabilities Integration and Development System (JCIDS): "A set or arrangement that results when independent and useful systems are integrated into a larger system that delivers unique capabilities."[1] Measuring mission and task performance enables the analyst to answer the warfighters' questions by describing how individual system performance affects the end-state performance of the SoS.

This SOP describes a process for developing measures based on terms and concepts found in JCIDS, the Department of Defense (DoD) acquisition process, joint publications, DoD Architecture Framework (DoDAF) products, and other authoritative sources. This process also draws from joint and Service source documents, known analytical methodologies, and the Capability Test Methodology (CTM) produced by the Joint Test and Evaluation Methodology (JTEM) Joint Test and Evaluation project and published in April 2009. This SOP was first developed as a product of the Metrics Working Group (MWG), which was comprised of joint, Service, and agency test and evaluation (T&E) community participants. The lead in this effort was the Director, Operational Test and Evaluation (DOT&E)-sponsored JTEM-Transition (JTEM-T) special project chartered to implement recommended methods and processes to improve the ability to conduct testing across the acquisition life cycle in a realistic joint environment. The MWG supported the United States Joint Forces Command (USJFCOM)/J89 Joint Mission Thread (JMT) Architecture and Test (JMTAT) Working Group by developing a process for measures development and an initial set of mission and task measures for selected JMTs.

Mission and task measures are developed to evaluate military capabilities used to achieve desired effects. Since there are diverse communities within the DoD, the measures will serve different purposes depending upon the needs of the various user communities. The JTEM-T team has built on this SOP to provide a complete end-to-end process that decomposes missions and tasks into attributes and measures, and then links system attributes and measures to task performance

Potential Uses for Mission and Task Measures

Provide the ability for:

- **Warfighters to assess the effectiveness of real-world operations.**
- **Trainers to assess the effectiveness of organizations, personnel, and tactics, techniques, and procedures (TTP).**
- **Acquisition/test community to assess the effectiveness of systems and address interoperability concerns.**

and mission effectiveness. This process is illustrated in figure 1-1 as a systems engineering "V" diagram. Note this will be referred to as the "T&E-V". The left side of the T&E-V is the decomposition process, whereas the right side of the T&E-V is the analysis process. The base of the T&E-V represents the test design and execution process where implemented to gather the data necessary for the evaluation. This SOP covers the left side, or measures development, of the T&E-V. A document describing the analysis process, the right side of the T&E-V, will be published in the near future and be available at https://acc.dau.mil/TIJE.

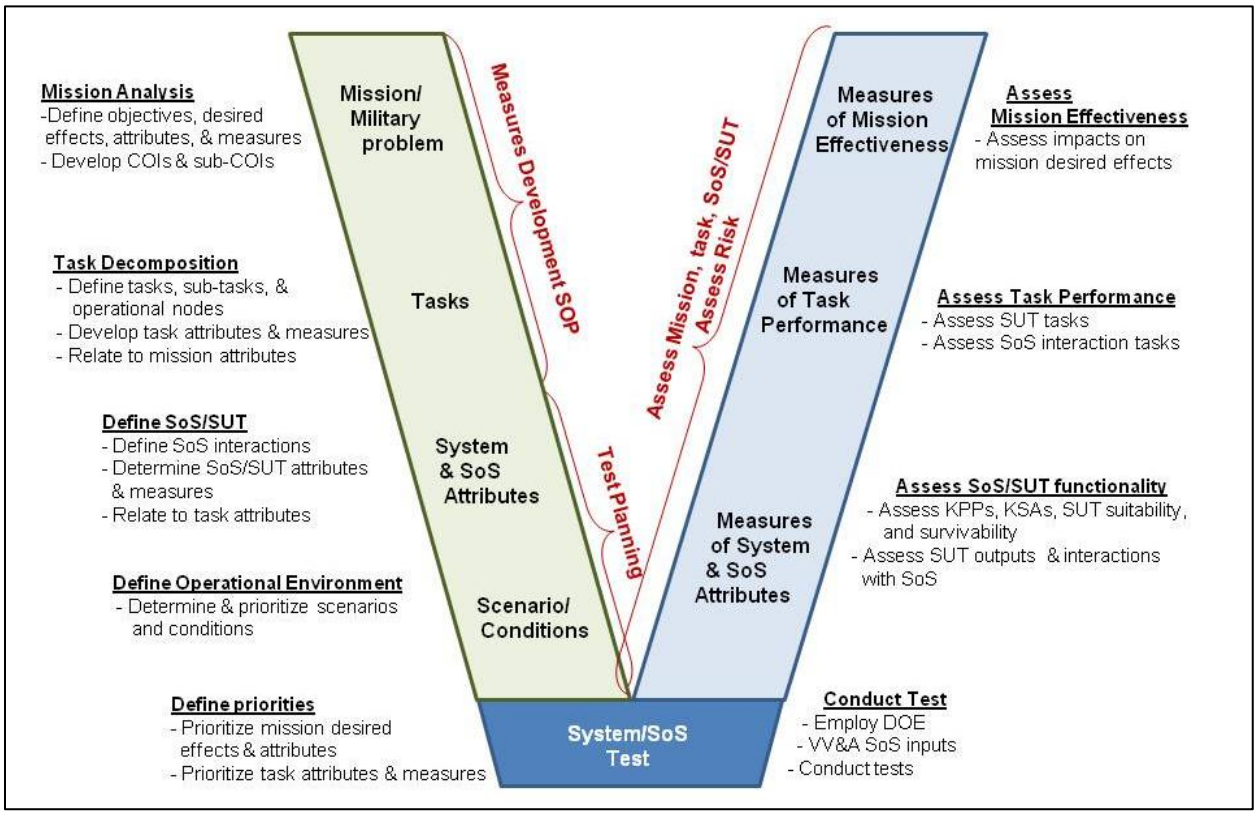

Figure 1-1. Measures Development & Assessment Process

KEY CONCEPTS IN MEASURES DEVELOPMENT

Measures Framework

Mission and task measures are based on a framework that is anchored to the JCIDS definition of "capability." The measures framework, as illustrated in figure 1-2, is a relationship diagram of capability key elements (that is, means and ways, desired effects, tasks, standards, and conditions). It identifies the basic questions of who, what, why, and how, and then connects measures to "how capable" is the "who and how" and "how well" is the "what and why." The measures framework relies on a lexicon derived from joint sources (Annex B, Terms of Reference), provides a logical framework for identifying measures in a joint mission environment, and enables traceability of measures back to capability requirements.

DEFINITION

A capability is defined as "the ability to achieve a desired effect under specified standards and conditions through combinations of means and ways across DOTMLPF to perform a set of tasks to execute a specified course of action."

[CJCSI 3170.01G, *Joint Capabilities Integration and Development System* (JCIDS), 1 March, 2009]

The measures framework follows the basic scientific concept of "cause and effect": *If an action is applied, then a reaction occurs.*[2] Carrying this thought further under a controlled set of conditions, one can think of the capability definition in terms of a hypothesis statement. Note that figure 1-2 is laid out in two sections with the bottom section representing the cause and the top section representing the effect. Mission and task-based measures focus on measuring the effects (that is, measuring how well tasks can be performed and how well desired effects can be achieved).

Capability Hypothesis

If one has a combination of means and ways under a set of standards and conditions, then one can perform tasks and achieve desired effects.

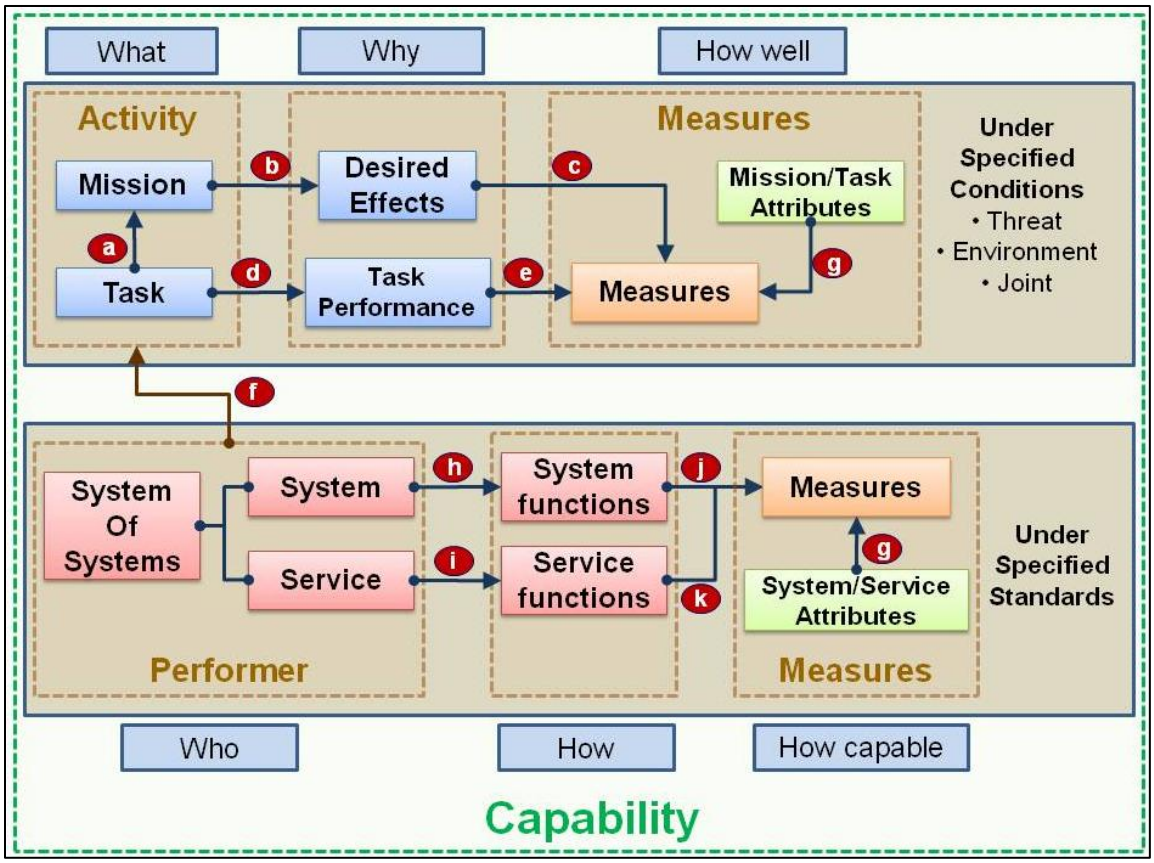

Figure 1-2. Measures Framework Relationship Diagram

Figure 1-2 references the DoDAF 2.0 meta-model (DM2) by labeling each association (arrow) with a letter. The letters refer to either actual DM2 associations or to implied associations based on DoDAF 2.0 definitions.[3] Table 1-1 provides an explanation and reference for each of the associations shown in figure 1-2.

Table 1-1. DoDAF 2.0 Associations Used in Measures Framework

ID	Association	Origin	End	Reference	DM2 #
a	A Mission consists of several or many Tasks (e.g. activities)	Task (activities)	Mission (project)	DM2	3
b	A Mission has Desired effects	Mission (project)	Desired effects	DM2	7
c	Desired effects are measurable	Desired effects	Measures	DM2	10
d	The performance of those Tasks as part of a Capability has Measures for their performance	Task (activities)	Task (activities) performance	DM2	17
e	The performance of Tasks under certain Conditions has Measures	Task (activities) performance	Measures	DM2	13
f	Performers perform Tasks (e.g. activities)	Performers	Task (activities)	DM2	20
g	A Measures is the magnitude of some Attribute of an object	Attribute	Measures	DoDAF 2.0, Vol 2, pg 125	
h	A Function that is performed by a System	System	System Functions	DoDAF 2.0, Vol 2, pg 42	
i	A Function that is performed by a Service	Service	Service Functions	DoDAF 2.0, Vol 2, pg 42	
j	Measures provide a way to compare Systems	System Functions	Measures	DoDAF 2.0, Vol 2, pg 125	
k	Measures provide a way to compare Services	Service Functions	Measures	DoDAF 2.0, Vol 2, pg 125	

Key Elements of the Measures Framework

The four key elements of the measures framework are as follow:

1. **Means and Ways**. A key element of the "capability" definition is the "means and ways." Means and ways across doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) describes the "who" and "how" across materiel and non-materiel attributes. Although means and ways are not well defined in authoritative sources, the *Capabilities-Based Assessment User's Guide* (Version 3, March 2009) describes "means" as types of solutions or resources that can be employed. It further defines "ways" as functions. Applying these definitions to DOTMLPF, "means" represents the materiel aspects of materiel, personnel, and facilities, while "ways" represent the non-materiel aspects of doctrine, organization, training, and leadership and education. Means and ways require a measure of how functional they are in terms of system and SoS attributes or parameters. System attributes are contained in approved capability documents, and are typically stated as Key Performance Parameters (KPP), Critical Technical Parameters (CTP), or Key System Attributes (KSA). While SoS attributes can be stated in the same manner, currently overarching "capstone" capability documents are not developed to formally define these SoS attributes. However, attributes that require interactions across systems (that is, interoperability, coordination, and so forth) may represent SoS attributes. To support this

concept, DoDAF 2.0 refers to "performers" as a resource that can consist of systems and services that are constrained by rules. It also refers to "systems" and "services" as performing functions and "measures" as providing a way to compare systems and services. The associations (g through k) in the measures framework relationship diagram are based on those DoDAF 2.0 references (table 1-1).

2. **Desired Effects**. An "effect" is defined in Joint Publication (JP) 3-0, *Joint Operations*, as "the physical or behavioral state [. . .] that results from an action, a set of actions, or another effect." Both the JCIDS Manual and JP 5-0, *Joint Operation Planning*, link desired effects in terms of mission outcomes and mission objectives. Desired effects are measured by determining that change in state. A change in a physical state is easier to evaluate, as it is usually immediate and can be seen, while a change in a behavioral state may not occur immediately and may not be easy to detect, making its evaluation more difficult. DoDAF 2.0 also uses desired effects and relates them to activities. The associations ***b*** and ***c*** used in the measures framework relationship diagram are based on those DM2 references.

3. **Tasks**. Chairman, Joint Chiefs of Staff Manual (CJCSM) 3500.04E, *Universal Joint Task List Manual* (UJTL Manual), defines a "task" as "an action or activity (derived from an analysis of the mission and concept of operations) assigned to an individual or organization to provide a capability." Thus, a "task" equates to an "activity" (as used in the DM2), and "performers perform activities" (association ***f***). Therefore, tasks are measured on how well they are performed. The associations ***d*** and ***e*** used in the measures framework relationship diagram show how measures are related to tasks and are based on DoDAF 2.0 references (figure 1-3).

   NOTE: Tasks are linked to mission using the DM2 association ***a***. While DM2 does not use the term "mission," it does refer to a "project" as consisting of many activities (tasks).

4. **Standards and Conditions**. According to the UJTL Manual, a "standard" is a way of expressing the acceptable proficiency that a joint organization or force must perform under a specified set of conditions. A standard consists of one or more measures for a task and a criterion for each measure. A "condition" is defined as those variables of an operational environment or situation in which a unit, system, or individual is expected to operate and may affect performance (JP 1-02, *Department of Defense Dictionary of Military and Associated Terms*). Although no associations to standards and conditions are shown in the measures framework relationship diagram, they will impact performance and achievement of desired effects.

Measures Framework Assessment Levels

The measures framework is characterized as having the following three levels of assessment: mission level to assess mission effectiveness, task level to assess task performance, and SoS/system level to assess SoS/system functions. Figure 1-3 illustrates that mission and task measures are focused on evaluating how well a capability performs tasks and achieves mission desired effects.

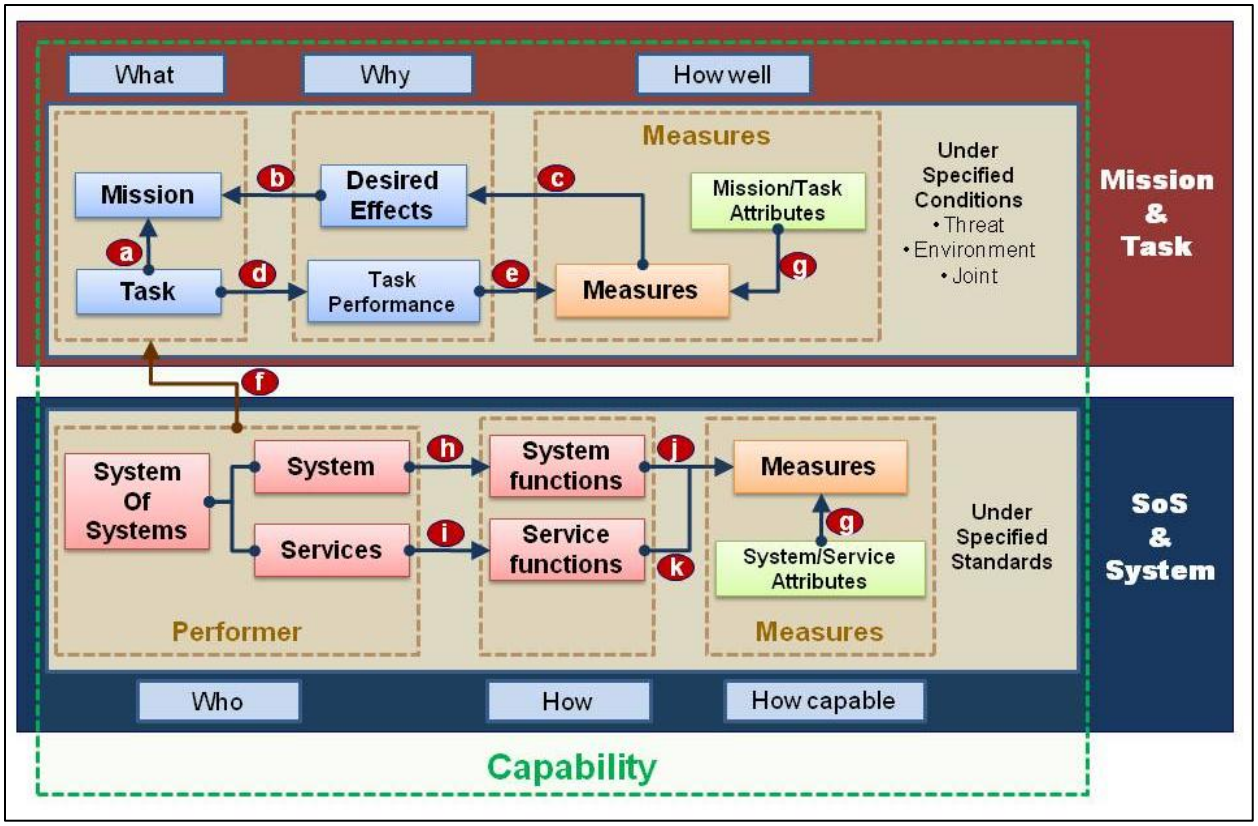

Figure 1-3. Measures Framework Relationship to Mission, Task, and Systems

Mission and task measures are focused on evaluating "how well" a capability performs tasks and achieves mission desired effects. SoS/system measures are focused on "how capable" the SoS and system are in terms of functionality and technical design. Mission measures are generally associated with a SoS. However, decomposing the mission into tasks and then selecting relevant segments of the mission thread will enable a focus at a system level that supports the overall SoS. System measures tend to focus on system-specific attributes that enable assessment of system functionality; how capable the system is at performing tasks. System attributes tend to be identified as Key Performance Parameters (KPPs), Key System Attributes (KSAs) and other system attributes.

ATTRIBUTES

Measures are developed around attributes. Attributes, as defined by JCIDS, are characteristics of elements or actions that can be measured quantitatively or qualitatively. Since mission and tasks are defined as activities, and systems are defined as things, attributes apply to each. The measures development process identifies attributes at the mission, task and system levels by examining mission, task, and system descriptions through JCIDS documents. Additional sources (joint doctrine, joint publications, future joint concepts, Analytic Agenda, etc.) can be used, as available, if more detail is needed for the measures development process.

DEFINITION

An attribute is defined as "A quantitative or qualitative characteristic of an element or its actions. [CJCSI 3170.01G, *JCIDS*, GL-3]

Mission and Task

Mission and task attributes focus on outputs; the results in performing the task to achieve the mission effects. For mission attributes, they describe characteristics of the mission desired effects that are needed to accomplish the mission objectives, i.e. changes in system behavior, capability, or the operational environment. Mission attributes can be either quantitative or qualitative depending on what is to be assessed. Task attributes are generally quantitative, but also can be qualitative when applied to task accomplishment. Task attributes help in assessing whether a task was completed to standard, or how much effort was involved.

Task and mission measures attempt to ascertain how well an activity was conducted; therefore, to find appropriate attributes, one must look for modifiers in the activity description that express "how well." For example, the third sentence (highlighted) in the following description provides how well an isolated person's location and status should be determined.

EXAMPLE

Sub-Task: Locate. If the isolated personnel's location is unknown at the time of the initial report, every effort must be made to determine the location and status. Without knowing where the isolated personnel is, recovery efforts cannot commence. The locate task involves the effort taken to precisely find and confirm the location and status of the isolated personnel. It starts upon recognition of an isolation event and continues until the isolated person is recovered. Locating may be accomplished by various means, such as intelligence collection assets, aircrews or ground forces, etc. An accurate location and positive authentication are normally required prior to committing recovery forces. However, this does not preclude the positioning of recovery forces to an area from which they can provide a faster response once the location and positive authentication is made. Location and authentication must be continually maintained and cross-checked throughout the support and recovery execution tasks.

[JP 3-50, Field Manual (FM) 3-50.1, and Subject Matter Expert (SME)]

Sentence diagramming[4] may be a helpful tool for determining modifiers (attributes). Figure 1-4 illustrates the Reed–Kellogg method. The example sentence can be diagrammed using this method to ensure all of the modifiers and relevant elements are identified. Although it is not necessary to use sentence diagramming, this method illustrates how modifiers can be clearly related to verbs and objects.

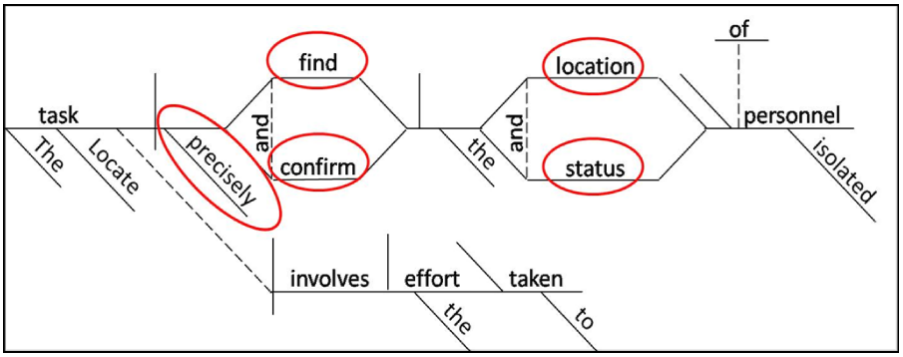

Figure 1-4. Reed-Kellogg Diagram

In this example, the **Locate** task performance is based on "precisely find location" and "precisely confirm status" of the isolated personnel. The primary modifier here is "precisely." Although "precision" may be used as the relevant attribute, "accuracy" is a more commonly accepted term. One way to quickly identify relevant elements without a formal sentence diagram method is to simply circle the adjectives, adverbs, verbs and objects in mission or task statements, then translate the modifiers into attributes.

Attribute Relationships

Attributes flow in one direction from mission to task to system/SoS (figure 1-5). An important attribute at the mission level may also be found at the task level (in some form) and at the system/SoS level. However, there may be additional attributes at the sub-task and system/SoS levels that are not at the higher task and mission levels. Those additional attributes will still be related to mission accomplishment and in some way support a higher level attribute. For example, if "timing" is an important attribute at the mission level, then one or more tasks will also have a timing attribute (or an attribute that enables timing). At the system level, the same concept applies. For example, an enabling system attribute might be "latency" applied to networks or system processing, thus affecting task or mission timing. In this way, deficiencies at the system level can be directly traced through attribute relationships to the task and mission levels.

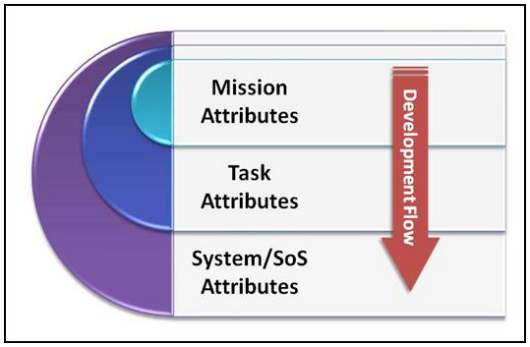

Figure 1-5. Attribute Levels

System/SoS Attributes

The JCIDS Manual details the process for developing system attributes in the form of KPPs and KSAs. KPPs are those system attributes considered most critical or essential for an effective military capability. KSAs are those system attributes considered critical or essential for an effective military capability, but not selected as KPPs. The difference between the two is in the level of management (JROC versus Service). The important point is that system attributes will usually have specific quality or quantity values of functionality stated in the Threshold/ Objective format. These system attributes (including KPPs and KSAs) should support and be traceable to the higher level task and mission attributes. The JCIDS Manual provides a list of common KPPs under six joint functions from JP 3-0 (C2, Intelligence, Fires, Movement and Maneuver, Protection, and Sustainment).[5]

Warfighter Prioritized Capability Attributes

The Joint Requirements Oversight Council [JROC] directed the combatant commands to develop a prioritized list of capability attributes that could be incorporated into the JCIDS manual.[6] Shown as table 1-2, they provide a common basis for defining and prioritizing capability characteristics in the four enabling capability portfolios: Battlespace Awareness, Command and Control [C2], Logistics, and Net-Centric.

Table 1-2. JCIDS Prioritized List of Capability Attributes[7]

Battlespace Awareness	
ISR	Environment
Comprehensive	Comprehensive
Persistent	Timely
Survivable	Integrated
Integrated	Persistent
Timely	Credible
Credible	Survivable
Adaptable	Adaptable
Innovative	Innovative

C2
Interoperability
Understanding
Timeliness
Accessibility
Simplicity
Completeness
Agility
Accuracy
Relevance
Robustness
Operational Trust

Net-centric			
Information Transport	Enterprise Services	Net Management	Information Assurance
Accessible	Accessible	Accessible	Security
Capacity	Interoperable	Dynamic	Available
Accurate	Survivable	Flexible	Timely
Timely	Timely	Agile	Accurate
Throughput	Reliable	Integrated	Visible
Expeditionary	Accurate	Maintainable	Responsive
Latency	Relevant	Complete	Controllable
	Scalable	Reconfigurable	Complete
	Responsive		
	Robust		

Logistics					
Deployment & Distribution	Supply	Maintain	Logistics Services	Operational Contract Support	Engineering
Visibility	Responsiveness	Sustainability	Responsiveness	Responsiveness	Effective
Reliability	Sustainability	Responsiveness	Attainability	Attainability	Expeditionary
Velocity	Flexibility	Attainability	Sustainability	Flexibility	Agile/Tailorable
Precision	Survivability	Flexibility	Flexibility	Survivability	Networked
Capacity	Attainability	Economy	Economy	Sustainability	Integrated
	Economy	Survivability	Survivable	Simplicity	Precise
	Simplicity	Simplicity	Simplicity	Economy	Enduring/ Persistence

MEASURES

A "measure" is defined as a parameter that provides the basis for describing varying levels of accomplishment.[8] Parameters are typically in the form of KPPs, CTPs, or KSAs that can be applied to systems and/or SoS. The levels of accomplishment are related to mission effects, task performance, and system functions. Measures consist of a scale and a measure description. The scale might be time, length, or quality, and the description may be in terms of the parameter or attribute that must be evaluated. Guidelines for writing measures are shown in the following callout box[9]:

MEASURE GUIDELINES

1. **Keep measures simple. A simple measure requires only a single measurement (for example, hours to develop an operation order).**
2. **Measures and criteria should reflect an understanding of activity.**
3. **Measures and criteria should reflect how an activity contributes to mission success.**
4. **Measures should be sensitive to the impact of conditions.**
5. **Measures should be developed that distinguish among multiple levels of performance. Good measures distinguish among multiple levels of performance (as opposed to go/no-go measures).**
6. **Measures should focus on the outputs, results of performance, or the process to achieve the activity. In identifying dimensions of performance, focus on the outputs or results of performance and, in selected cases, the process followed (for example, number or percentage of sub-steps performed correctly or in the correct sequence). The dimensions of performance should not be peculiar to a specific means and ways; rather, they should apply to all combinations of means and ways that can be employed.**
7. **Measures should try to take advantage of the strengths of both absolute and relative scales. Absolute scales are those that, beginning from a start point (usually zero), measure the number of occurrences, the amount of time, or the movement across distance. The advantage of absolute scales is that the result or output is clearly specified. The disadvantage is the lack of information about the adequacy of any particular value (from simply looking at the measure) on the absolute scale. Relative scales are those that compare a particular value to the total and are often expressed as a proportion or percentage (for example, percent complete). The advantage of relative measures is that they clearly indicate the degree of completion. The main disadvantage is that such measures do not indicate the size or scope of effort.**

Chairman, Joint Chiefs of Staff Manual (CJCSM) 3500.04E

Measure Types

Common terms for measures used by DoD components include measure of effectiveness (MOE), measure of performance (MOP), and measure of suitability (MOS). Authoritative definitions are listed in Annex B, Terms of Reference. However, there are varying interpretations of these definitions, particularly in the use of MOEs and MOPs. Recent guidance from the DOT&E to the operational testing community attempted to establish a more uniform approach in the use of MOEs and MOPs. The memorandum states that "... measures of effectiveness […] measure the military effect (mission accomplishment) that comes from the use of the system in its expected environment."[10] In addition, the memorandum directs that system-particular performance parameters (KPPs, KSAs, and other attributes) should be referred to as "measures of performance." To avoid further confusion or discussion on the use of these terms, this SOP will refer to the measures by the "level of accomplishment."

Levels of Measures

- **Mission Measures** - Intended to measure effects
- **Task Measures** - Intended to measure task performance
- **SoS Measures** - Intended to measure SoS functions
- **System Measures** - Intended to measure system functions

Measure Relationships

Just as attributes are related across mission → task → system/SoS levels, a measures relationship may also exist across measurement levels. Figure 1-6 illustrates an example of a "timeliness" attribute transitioning across several levels of activities (mission → task → sub-task). This means a measure is required at each activity level, and a relationship is required with each measure (for example, the time to complete the sub-task will impact the time to complete the task and the mission). Although the example in figure 1-5 seems relatively straightforward, it is not easy to create measures for every attribute.

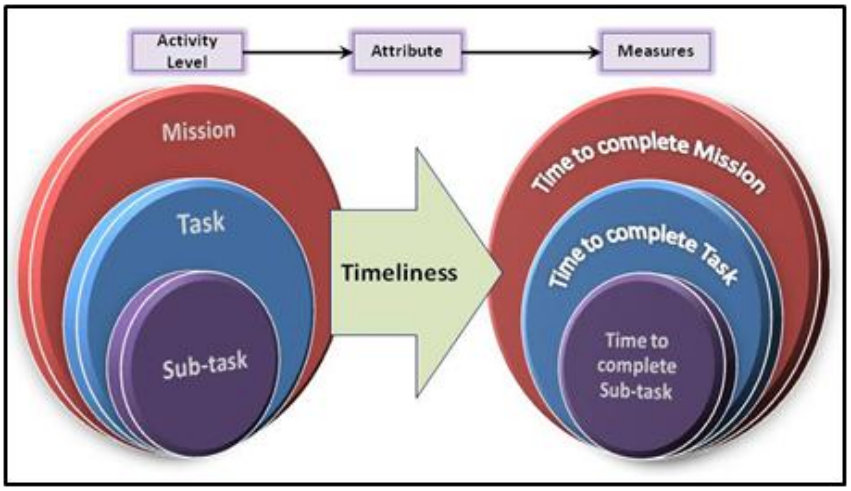

Figure 1-6. Measures Relationship Illustration

Figure 1-7 uses an example attribute ("accuracy") from the Joint Personnel Recovery (JPR) mission thread for a task and sub-task. Note that what is shown is not well-defined or measurable. Each activity level requires a better understanding of what needs to be measured. Consider that each activity is a basic input-output model, measuring the output is the important point. So, at each level one may ask, "What is the output of that activity?" Referring to the example in figure 1-7, what is the output of the **Locate** task that requires accuracy? The desired output is to provide a situation report (SITREP) that leads to planning the **Recovery** task of the JPR mission thread.

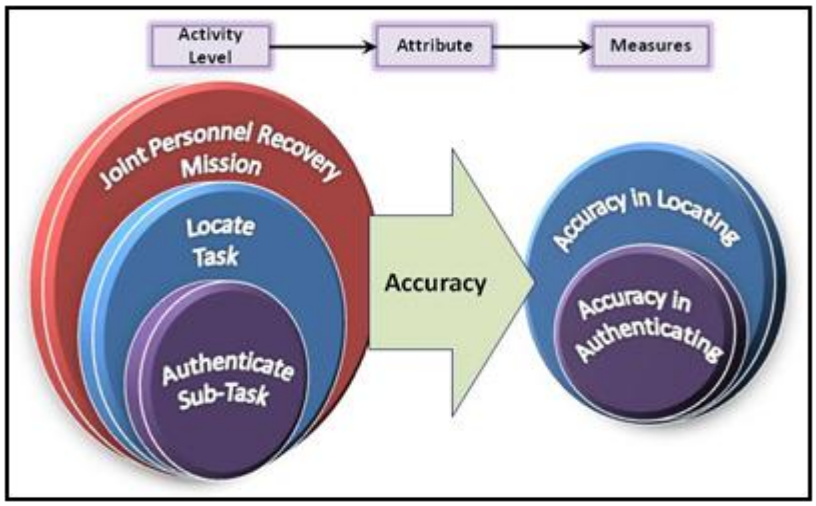

Figure 1-7. Measures Relationship Example

The "accuracy" measure of the output is the content of the message that becomes the input for the next task. To be "accurate" may include accuracy in the location of the Isolated Personnel (IP), accuracy in the identity of the IP, and accuracy in the transfer of the information, all of which may be measured in sub-tasks. However, the measure for accuracy at the **Locate** task level may be, "Is the SITREP provided to the recovery planners accurate in content and context compared to ground truth?" The **Authenticate** sub-task will focus on its own output (authentication of the IP). Therefore, the measure may be, "Is the identity of the IP correctly authenticated?"

Capabilities-Based Assessment

If a capabilities-based assessment (CBA) is available, the measures development process should leverage information already developed during the analysis phase. The CBA identifies scenarios, military objectives, mission outcomes, associated desired effects, and task representations. Ideally, this description of mission and tasks, along with their associated attributes and measures is included in the JCIDS Initial Capabilities Document and the Capability Development Document. In either case, this information should be leveraged to determine mission and task attributes and measures.

Mission Threads

A mission thread provides a conceptual thread of nodes, tasks, and interactions at the Service or joint level and can provide the basis for conducting a mission analysis and the development of mission and task-based measures. Threads should be based on current DoDAF architectures in

order to provide the data required to document the tasks and activities within a mission thread. All elements of DoDAF architectures should be present in the mission thread artifacts, including activities, performers, information need lines, organizational relationships, and possible systems.

THE JOINT CONDITION

Overview

According to the "capability" definition, capabilities exist under a set of standards and conditions. Conditions are those variables of an operational environment or situation in which a unit, system, or individual is expected to operate and may affect performance (CJCSM 3500.04E). The "joint condition" establishes the requirement that a unit, system, or individual will operate with other units, systems, or individuals that cross military Services, doctrine, or areas of responsibility. Joint "connotes activities, operations, organizations, etc., in which elements of two or more Military Departments participate."[11] The "joint condition" can also be used to include Coalition Forces and other government agencies.

The "joint condition" establishes the requirement that a unit, system, or individual will operate with other units, systems, or individuals that cross military Services, doctrine, or areas of responsibility.

The UJTL Manual describes the operational context for selected mission tasks by referring to physical, military, and civil environments as categories of conditions. Under each of these environments is a list of conditions that express variables that affect task performance. Among these conditions are the possible forces and materiel that will compose the performers (the "who") that function and execute a task. This range of joint organizations, equipment, and TTP is an important condition to consider when JMTs and subsequent strands are developed and implemented. One method for determining the applicability of joint representation is to analyze the sensitivity of the task(s) to changes in joint representation. Although it is possible to develop a mission thread from a single Service without applying joint conditions, it may not be operationally representative of the environment. Regardless, the joint condition should be satisfied sufficiently to minimize the risk of missing an important factor in representing the operational environment.

Measures and the Joint Condition

The UJTL Manual characterizes the type of conditions that should be considered in an operational context as follows: "Conditions that are relevant affect performance of the task. If the condition does not affect how to train, organize, or equip to perform a task, it is not relevant and should not be used."[12] The ultimate question is whether or not the task will be affected by varying the SoS configuration. When measuring a task, there are two types of variables, dependent and independent. Measures are dependent (response) variables, conditions are independent variables (test factors), and the task and mission are set constant. The value of dependent (response) variable changes as a direct result of changing the independent variables (test factors). Figure 1-8 illustrates the relationship where changes in the independent variables will cause a different value in the measure. (The scale moves only when a change occurs on the right side in the independent variables).

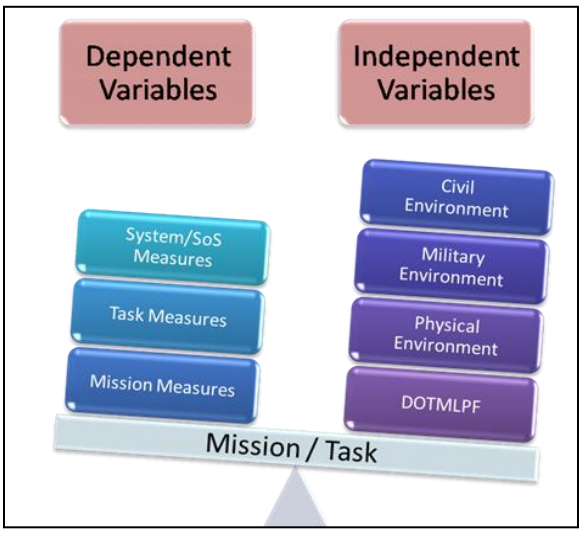

Figure 1-8. Variable Relationship

Among others, independent variables can include land, sea, air, cyberspace, threat, political policies, culture, economy, and variations in DOTMLPF. For the purposes of assessing system impact on the SoS, the focus is on the joint condition (that is, the SoS configuration where interactions occur in the conduct of the mission).

Determining the Joint Condition

Figure 1-9 shows a decision tree to determine the applicability of the joint condition. To answer the questions, the developer needs to research the possible organizations and systems that can represent the logical nodes or execute the tasks in the mission thread. The following steps demonstrate how to determine the need for a joint condition when developing a specific mission strand.

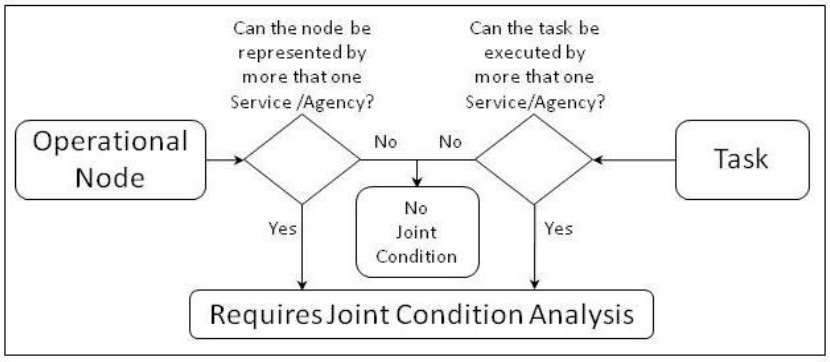

Figure 1-9. Joint Condition Decision Tree

Mapping the Joint Condition

1. The Operational Viewpoint (OV)-5b Operational Activity Model may identify tasks for the joint condition. Figure 1-10 is an example of an OV-5b for the JPR **Locate** task.

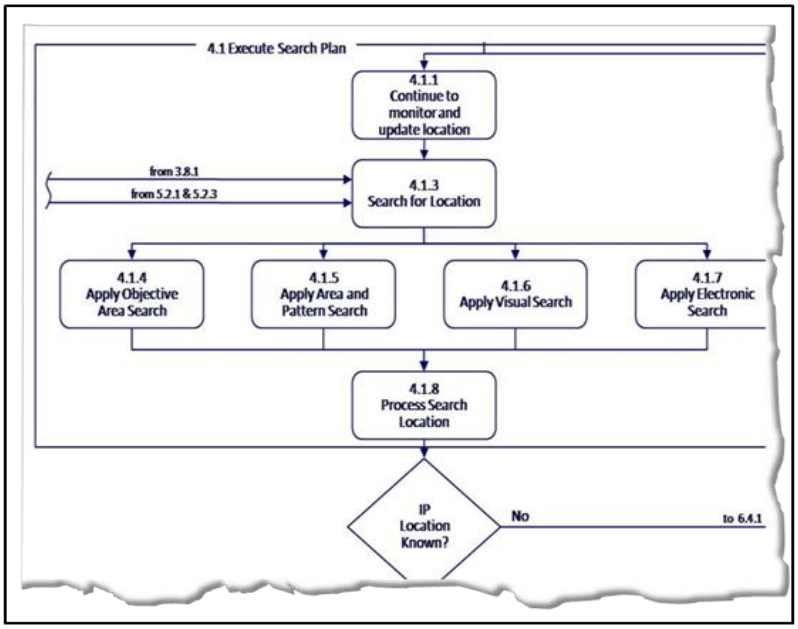

Figure 1-10. JPR Locate OV-5b Extract

For each activity/task, identify the node using the OV-2 Operational Resource Flow. Figure 1-11 is an example of **an OV**-2 for the JPR **Locate** task.

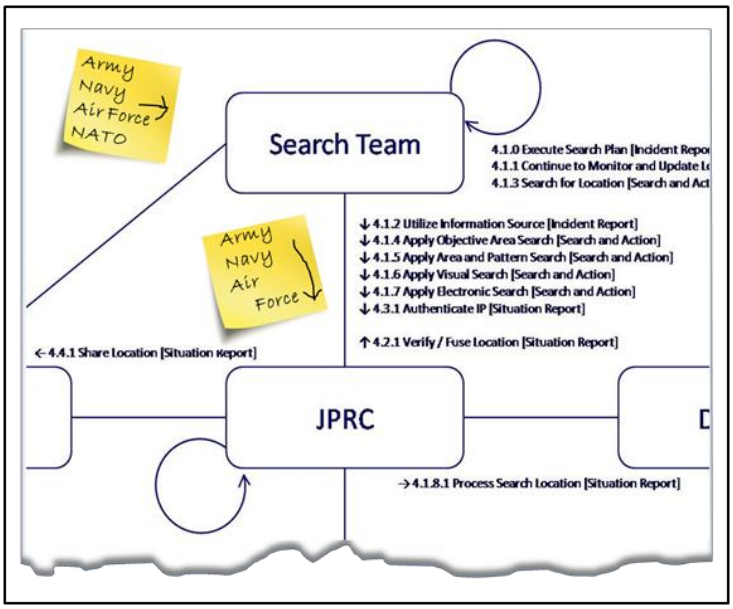

Figure 1-11. JPR Locate OV-2 Extract

2. For each node in the OV-2, identify the Service, component, and/or coalition performer(s) who could represent that node for each activity/task identified. Map these relationships in table form as shown in figure 1-12.

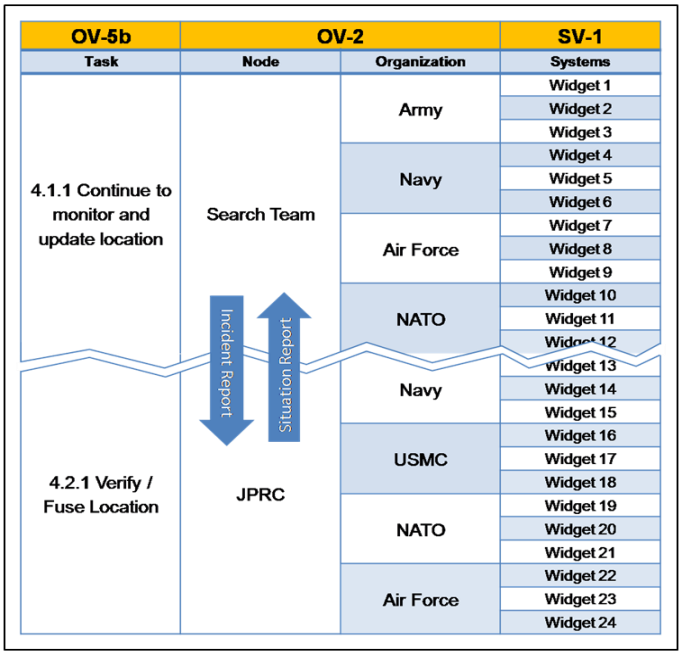

Figure 1-12. Tasks and Nodes with Possible Organizations and Systems

3. A square matrix is developed to map the possible combinations of organizational interactions that may occur for each activity in the mission. This results in the possible combinations of "joint" players that can make up the SoS (figure 1-13).

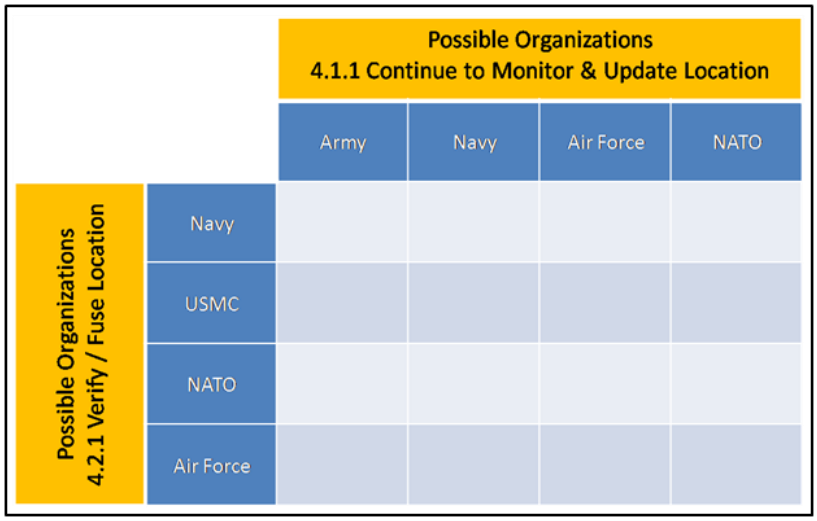

Figure 1-13. Possible Organizations

4. For each Service, component, and/or coalition node identified in step 4 determine specific systems that can be used for each activity/task. Remove duplicates to produce a systems list for each activity. The possible systems for each task are listed in a square matrix to show the combinations of joint systems (potential SoS configurations) that could make up the mission (figure 1-14).

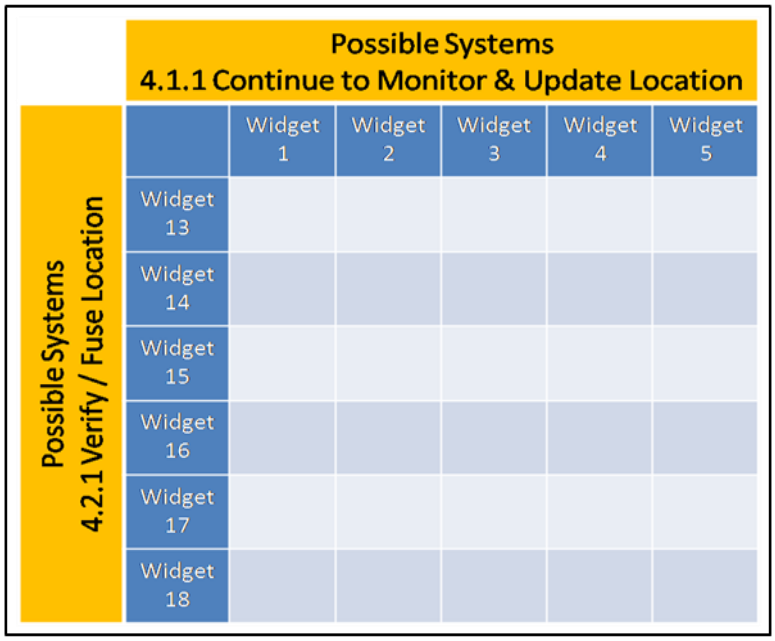

Figure 1-14. Possible Systems

Joint Condition Analysis

Once all of the possible organizations and systems have been mapped for each node/task, the mission strand developer can determine which tasks will require a joint condition. In the case of the T&E of a new system, determine if the system is sensitive to a change in nodal representation. For example, using figure 1-14, if there is a possible system with which the system under test must interact, then there will be an interoperability concern and the joint condition must be satisfied in the test design. If the purpose is to design a training venue and possible systems will cause the unit to have to train, organize, or equip themselves differently, then those elements of the joint condition must be incorporated in the system-specific instantiation. The decision tree in figure 1-15 illustrates this point. After this analysis, the mission strand developer can clearly articulate which portions of the joint problem will be addressed. Similarly, the mission analyst can determine if the strand was developed robustly and will address adequately the required joint environment.

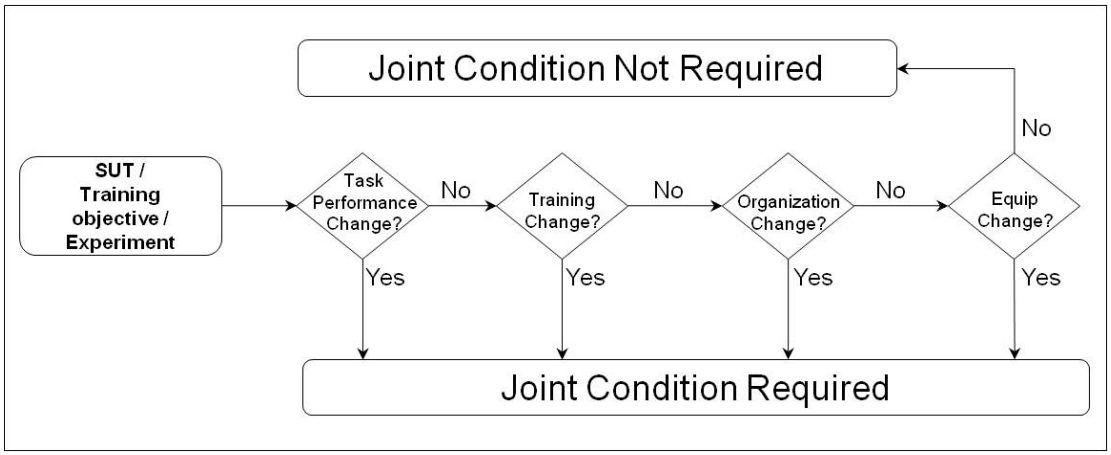

Figure 1-15. Joint Condition Analysis

MISSION-TASK CONUNDRUM

A mission can be described in terms of an applicable mission statement, mission objectives and desired effects. JP 5-0, Joint Operation Planning, provides detailed guidance in conducting a mission analysis. In short, a mission should be defined in broad terms of a mission statement and mission objectives. The mission statement should be a short sentence or paragraph that describes the organization's essential task (or tasks) and purpose — a clear statement of the action to be taken and the reason for doing so. The mission statement contains the elements of who, what, when, where, and why, but seldom specifies how. It should be framed as a clear, concise statement of the essential tasks to be accomplished and the purpose to be achieved. The mission objective is a clearly defined, decisive, and attainable goal toward which every military operation should be directed. Although joint doctrine does not prescribe a specific convention for writing an objective statement, there are three primary considerations. Mission objective statements should: 1) link directly or indirectly to one or more high-level objectives, 2) be as unambiguous as possible, and 3) not specify ways and means for their accomplishment.

A desired effect can be thought of as a condition that can support achieving an objective. Although doctrine does not prescribe a specific convention for writing a desired effect statement, there are four primary considerations: 1) each desired effect should link directly to one or more objectives; 2) the effect should be measurable; 3) the statement should not specify ways and means for accomplishment; and 4) the effect should be distinguishable from the objective it supports as a condition for success, not as another objective or a task. It is important to define desired effects so that the impact of system function and task performance can be assessed at the warfighter mission level.

TIP

Identifying the missions and desired effects makes it possible to develop measures which can be used to assess the impact of system performance on the overall SoS. This, in turn, enables the analyst to answer the "So What?" questions concerning how well an individual system under test supports the warfighter.

A task is defined as an action or activity (derived from an analysis of the mission and concept of operations) assigned to an individual or organization to provide a capability (UJTL Manual). As stated in the definition, tasks are assigned to individuals or organizations, not systems. Systems do not accomplish tasks. Rather, systems support the accomplishment of tasks by operational users. Tasks based on mission analysis and approved by the commander that are absolutely necessary, indispensable, or critical to the success of a mission are considered "mission-essential tasks". Supporting tasks are specific activities that contribute to accomplishment of a mission-essential task. Tasks may be found in joint and Service task lists. Mission-essential task lists for organizations may provide a good source for identifying tasks.

Mission and task terms tend to be confusing and used interchangeably. By definition, a mission differs from a task in that a mission has a purpose. But it can be argued that a task has a purpose

as well. The result is a source of confusion over mission versus task. It is suggested that the difference in a mission and a task is not whether there is a purpose, but who benefits from the purpose. Think of mission-essential tasks as those activities or actions performed by an operational user and a system/SoS in order to complete a mission. A mission has a beneficiary that is different from the operational user. For example, an aircraft may conduct a close air support (CAS) mission to support ground troops. The pilot is the operational user of the aircraft (system), but the beneficiary is the ground troops. Thus the pilot's mission desired effects are based on the needs of the beneficiary (i.e. ground troops desire to maintain forward momentum, reduce threats, minimize risk). The pilot's CAS mission is considered by the ground troops as a "supporting task". Tasks are performed with a purpose to provide a product or output that supports other tasks and missions by other operational users. Measuring task performance is based on attributes of the product or output from the operational user perspective. Using the CAS example, the pilot performs his mission-essential tasks where his output may be measured by time, accuracy, completeness.

In summary, a mission may be thought of as a description of the set of essential tasks (mission statement), a description of the products and outputs (objectives), and a list of desired effects that are based on operational need of the user or consumer of those products and outputs. The operational user's mission is considered a supporting task by the mission beneficiary. That beneficiary performs his own mission-essential tasks as a mission in support of another beneficiary; and so on.

EXAMPLE

Consider the test of an aircraft radar test set. At the lowest level, this test set would support tasks conducted by aircraft maintenance technicians whose "mission" would include troubleshooting and repairing radar systems. The mission output for these maintenance personnel (i.e., up and ready radar systems) would, in turn, support aircrew "missions" which would, by extension, support the mission of the squadron, the air wing, and the ship; ultimately flowing up to the highest levels in the chain of command. If the test team considered the air wing or ship to be the intended operational user for the test set, the tasks identified (and the resulting COIs) would be greatly different than the tasks that would be identified if the test team instead considered the maintenance personnel to be the operational users. While maintenance personnel tasks might be included as subtasks under the ship's tasks, ultimately, the end-to-end test of whether the air wing or ship could accomplish its assigned missions with support from the aircraft radar test set would be considered "overkill."

On the other hand, if the test team selected maintenance personnel as the operational users, but the aircraft radar test set was actually calibrated and maintained by ship (AIMD) personnel, the end-to-end test of whether the radar test set supported the "mission" of "providing up and ready radar systems" might not provide the true mission context for the SUT.

(Continued) Scoping the SUT as a "radar test set" and operational user as the aircraft maintenance technicians, the mission objectives would include troubleshooting and repairing radar systems. The aircraft maintenance technician performs mission-essential tasks of calibration, connecting, and analysis. However, the mission output for these maintenance personnel (i.e., up and ready radar systems) would, in turn, support aircrew "missions". Thus the essential tasks performed by the aircraft maintenance technicians are considered supporting tasks by the aircrews, with the aircrews being the intended user or consumer of the essential tasks. In this case, the mission statement and objectives would be based on the aircraft maintenance technicians troubleshooting and repairing radar systems, but the desired effects are based on the need or impact to the aircrews. A desired effect may be to "maintain operation of aircraft radars in 95% or aircraft at all times.

At times the SUT may act as a part of a system of systems that is performing an operational mission, such as Close Air Support. In this case, the mission statement and objectives is based on the SoS users and the desired effects are based on the warfighter on the ground that is benefiting from the CAS mission.

CRITICAL OPERATIONAL ISSUES

Critical Operational Issues (COIs) are used within the test community to formulate the basis for a test that is focused on operational effectiveness and operational suitability. COIs are the operational effectiveness and operational suitability issues (not parameters, objectives, or thresholds) that must be examined in operational test and evaluation (OT&E) to evaluate and/or assess the system's capability to perform its mission. Effectiveness COIs are typically mission focused, stated as a question: "Can the SUT support the _____ mission"?

DEFINITION

A Critical Operational Issue (COI) is "a key Operational Effectiveness (OE) and/or Operational Suitability (OS) issue (not a parameter, objective, or threshold) that must be examined in OT&E to determine the system's capability to perform its mission. A COI is normally phrased as a question that must be answered in order to properly evaluate OE or OS."

Since operational effectiveness COIs are based on missions, these COIs may be broken down into sub-COIs that focus on mission desired effects. Although these sub-COIs can be written as questions, it is suggested that sub-COIs take the form of "Assess SUT impact on mission desired effect". Developing sub-COIs that are based on mission desired effects provides options in assessing the mission. In some situations, it may not be feasible to conduct test vignettes that include the SoS elements needed to measure mission desired effects. When possible, data should be collected on mission measures that allow a quantitative assessment of the mission. However, the alternative is to make a qualitative assessment of mission desired effects through assessing sub-COIs. Thus in developing a test report on the SUT, the report will include a written assessment on how the SUT supports each mission desired effect.

EXAMPLE

The F-35 aircraft is assigned the mission to conduct Close Air Support. The F-35 will act as the strike aircraft to attack enemy targets for friendly ground forces. The ground force is the beneficiary of the CAS mission with desired effects of: (1) Reduce threats, (2) Minimize collateral damage, & (3) Prevent fratricide. The COI and sub-COIs may be written as:
COI: Can the F-35 support the CAS mission?

Sub-COI: Assess the F-35 impact on reducing threats.

Sub-COI: Assess the F-35 impact on minimizing collateral damage.

Sub-COI: Assess the F-35 impact on preventing fratricide.

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CHAPTER 2
MISSION AND TASK MEASURES DEVELOPMENT

OVERVIEW

The measures development process is based on the relationships depicted in Figure 1-2, Measures Framework Relationship Diagram. The process breaks down each relationship through a step-by-step process that decomposes into a series of relational matrices. This measures development process is based on a widely accepted Quality Function Deployment (QFD) business model.[13] The QFD process was developed to enable product developers to improve the way they specified the requirements for their products, demanding that each requirement be traceable back to a customer need. The same concept can be applied to the military model of system/SoS that provides the capabilities needed to satisfy warfighter requirements.

INITIATING THE MEASURES DEVELOPMENT PROCESS

Measures development can begin in conjunction with a mission analysis effort. The DoDAF artifacts produced will facilitate a mission decomposition and analysis process that will describe warfighter requirements and result in identification of mission, task, SoS, and system measures (figure 2-1). This process will involve a series of steps intended to decompose the measures relationship into relational elements that can support traceability back to the warfighter requirements. The steps are shown in the following callout box.

Mission Thread Analysis Steps

- Step 1: Mission Decomposition and Mission Level Measures
- Step 2: Task Decomposition and Task Level Measures
- Step 3: System/SoS Functionality Decomposition and Measures

Figure 2-1. Mission Analysis

Step 1: Mission Decomposition

Overview

Figure 2-2 shows the basic elements for decomposing mission warfighter requirements to mission measures. This construct follows the Joint Operation Planning Process of describing the mission in terms of objectives, effects, and tasks. It also follows the same basic flow of the JCIDS CBA by examining the mission objectives, including outcomes and associated desired effects. These elements are necessary to determine the relevant attributes and eventual measures.

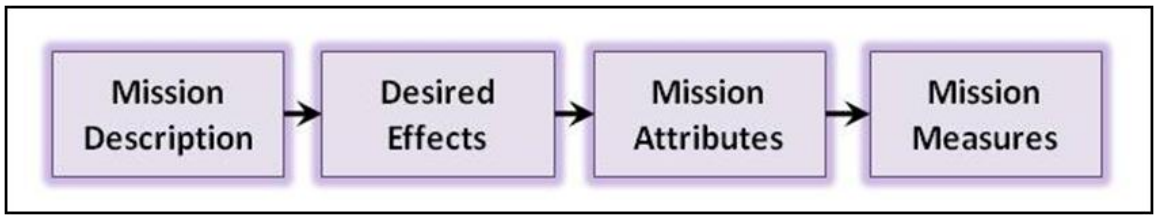

Figure 2-2. Mission Decomposition Flow

Element Descriptions

- **Mission Description**. JP 5-0 provides detailed guidance for conducting a mission analysis. In short, a mission should be defined in broad terms of a mission statement and mission objectives.
- **Mission Statement**. The mission statement should be a short sentence or paragraph that describes the organization's essential task(s) and purpose, that is, a clear statement of the action to be taken and the reason for doing so. The mission statement contains the elements of who, what, when, where, and why, but seldom specifies how. It should be framed as a clear, concise statement of the essential tasks to be accomplished and the purpose to be achieved.
- **Mission Objectives**. An objective is a clearly defined, decisive, and attainable goal toward which every military operation should be directed. Although joint doctrine does not prescribe a specific convention for writing an objective statement, the three primary considerations follow:
  - They should link directly or indirectly to one or more higher-level objectives
  - They should be as unambiguous as possible
  - They should not specify ways and means for their accomplishment.
- **Desired Effects**. The Joint Operation Planning Process discusses the use of desired and undesired effects in joint operation planning as a way to clarify the relationship between objectives and tasks. An "effect" is a physical and/or behavioral state of a system[14] that results from an action, a set of actions, or another effect.[15] A desired effect (DE) can be thought of as an "element of success" that can support achieving an associated objective, while an undesired effect is a "negative element of success" that can inhibit progress toward an objective. Although joint doctrine does not prescribe a specific convention for writing a desired effect statement, the four primary considerations follow:

- Each desired effect should link directly to one or more objectives
- The effect should be measurable
- The statement should not specify ways and means for accomplishment
- The effect should be distinguishable from the objective it supports as an element of success, not as another objective or a task. The same considerations apply to writing an undesired effect statement.

TIP

Objectives prescribe friendly goals.

Effects describe behavior in the operational environment.

Desired effects are "elements of success" related to achieving objectives.

Tasks direct friendly action. Source: JP 5-0, Page III-14

- **Mission Attributes**. An attribute is defined as a quantitative or qualitative characteristic of an element or its actions.[16] At the mission level, the focus is on identifying attributes of desired effects. When appropriate, SWarF prioritized attributes associated with relevant JCAs may be used.
- **Mission Measures**. Mission measures are used to assess changes in behavior, capability, or the operational environment. They measure the creation of an effect. Mission measures typically are more subjective than other measures, and can be crafted as either qualitative or quantitative. Mission measures may reflect a trend and show progress toward a measurable threshold.

Process

The Step 1 process involves a decomposition of mission description, effects, and attributes to measures. Figure 2-3 illustrates that this process may be executed through a series of matrices that support the traceability of a mission measure back to mission desired effects and objectives. Each matrix is intended simply to map relationships between the rows and columns. For example, Matrix 1 would consist of mission objectives as rows and desired effects as columns. If desired effect A was related to mission objective A, then an X would be placed in the upper left-hand box of the matrix. As an option, the developer may wish to prioritize relationships to focus on key relationships. In some situations, the mapping for a matrix may already exist in a DoDAF artifact. The analyst then has the option to use the existing artifact to document the relationships or remap as a matrix for this decomposition process.

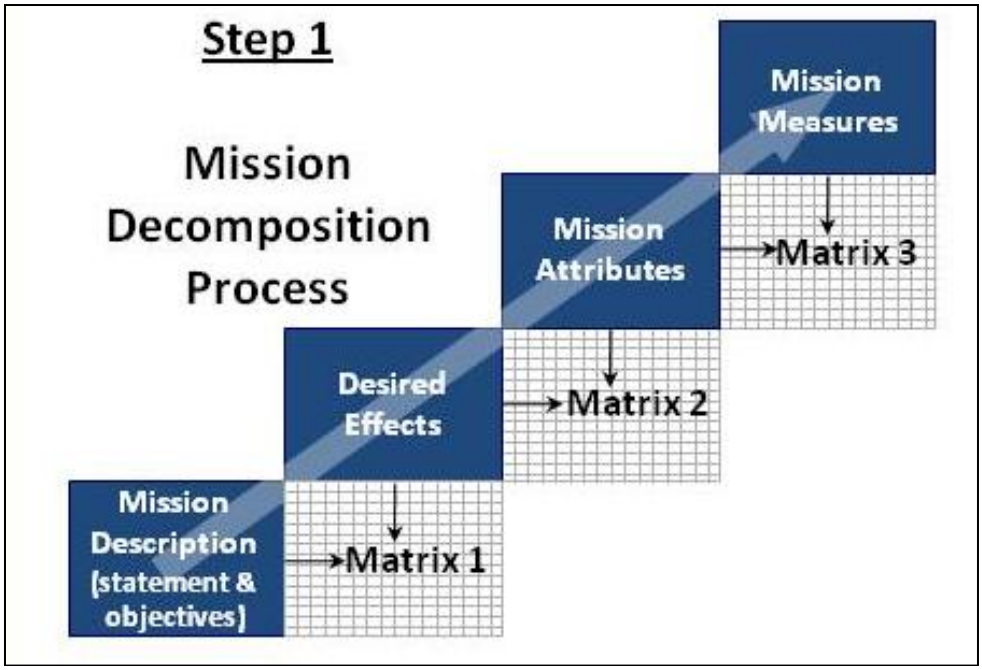

Figure 2-3. Mission Decomposition Process

Matrix 1: Mission Description – Desired Effects

The most difficult task in developing any of these matrices is locating the correct information. Of course, this depends on the quality of the data that is available. In the case of Matrix 1, mission description (mission statement and objectives) and desired effects should be identified for a Tier 1 JMT and listed in the All Viewpoint (AV)-1. (DoDAF 2.0 specifies that the AV-1 contains vision, goals, objectives, or effects.[17]) If not in the AV-1 (or if no AV-1 exists), the next logical place to find this information is within authoritative sources such as joint doctrine, CONOPS, or other JPs. When necessary, subject matter experts (SME) may be used to augment or clarify information from authoritative sources. Once the mission description and desired effects are determined, the mapping process must occur. The mapping process may require some analysis by hypothesizing the following: "If one can achieve this desired effect, then one will have helped to accomplish the mission objective." If the answer is "yes," then the relationship exists. Figure 2-4 provides an example format for Matrix 1, which may be modified as desired.

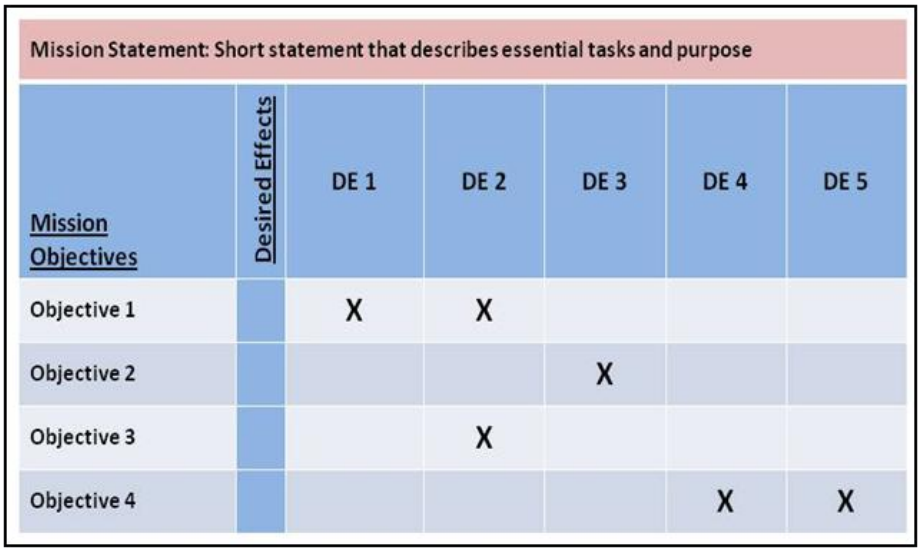

Figure 2-4. Matrix 1 Example Format

General Guidelines for Determining Matrix 1 Relationships

- The number of desired effects should be greater than or equal to the number of objectives.
- Ensure there is at least one desired effect mapped to each objective.
- Ensure each desired effect is mapped to at least one objective.

Matrix 2: Desired Effects – Mission Attributes

Matrix 2 continues the Step 1 process by mapping attributes to desired effects. Since desired effects were already identified in Matrix 1, the job of creating Matrix 2 is partly done. What needs to be identified now are the attributes. Follow the basic direction provided in chapter 1 for determining attributes. Additional guidelines relevant to determining mission level attributes are provided in the following callout box. Matrix 2 complies with a simple format of desired effects and attributes as rows and columns, respectively, with relationships mapped. See figure 2-5 for an example of the format.

General Guidelines for Determining Matrix 2 Relationships

- Use SWarF prioritized attributes when appropriate.
- Look at authoritative documents for indicators of mission level attributes.
- Consider the language used to describe each desired effect. Identify and translate modifiers into attributes.
- It may be helpful to categorize the type of desired effect based on the effect definition. Table 2-1 shows different categories of desired effects and some example attributes. This list is not all-inclusive.
- Each desired effect must have at least one attribute mapped to it.
- The number of attributes may exceed the number of desired effects.

Table 2-1. Categories of Desired Effects and Example Attributes

Categories of Desired Effects & Relevant Attributes					
Change in physical state of a system/SoS	Change in behavioral state of a system/SoS	Result, outcome, consequence of an action	Change to a condition	Change to a behavior	Change to a degree of freedom
Mobility	Accuracy	Capable	Informed	Willingness	Available
Lethality	Timeliness	Readiness	Supplied	Responsive	Capable
Networked	Agile		Trained		
Collector	Adaptable		Command		
Survivable					

Desired Effect	Attributes	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Attribute 5	Attribute 6
DE 1		X			X		
DE 2			X	X			
DE 3			X			X	
DE 4				X			
DE 5						X	X

Figure 2-5. Matrix 2 Example Format

Matrix 3: Mission Attributes – Mission Measures

Matrix 3 is the last mapping done as part of Step 1. This will result in a list of mission measures that can be mapped back to mission effects and objectives. Using the attributes from Matrix 2, analysts can develop a list of mission measures and document their mapping to the relevant attribute.

The general process for developing a measure starts with an attribute. Since the focus is on a mission desired effect, the measure should assess an attribute of the desired effect. If the attribute is a physical characteristic such as "mobility," then the assessment will need to measure a physical change in resources (that is, speed of advance). Conversely, if the attribute is a behavioral characteristic such as "morale," then the assessment will need to measure a change in behavior or some resultant actions that are based on mental states (that is, willingness to fight).

Some measures of mission effectiveness may be binary "yes/no" type measures. For example, in JPR a desired effect is to return the IP to duty. The measure may then be whether the IP was returned to duty. This measure may be better written to assess the desired effect across numerous iterations of the JPR mission thread (that is, the percentage of JPR missions where the IP was returned to duty). A measure consists of a scale and a description. In this example, the scale is "percentage" and the description is "of JPR missions where the IP was returned to duty." Matrix 3 (figure 2-6) follows a simple format of attributes and measures as rows and columns respectively with relationships mapped.

Attribute	Measures	Mission Measure 1	Mission Measure 2	Mission Measure 3	Mission Measure 4	Mission Measure 5
Attribute 1		X				
Attribute 2			X	X		
Attribute 3					X	
Attribute 4						X

Figure 2-6. Matrix 3 Example Format

General Guidelines for Determining Matrix 3 Relationships

- Write measures using the guidance provided in chapter 1.
- There should be at least one measure identified for each attribute.
- Each measure should have a scale and a description.
- Each measure should assess a physical or behavioral change in state.

Step 2: Task Decomposition

Overview

Figure 2-7 shows the basic elements for decomposing mission warfighter requirements to task measures. This construct uses OVs from a JMT Tier 1 or other authoritative source to identify generic operational nodes that are NOT system specific and decompose the mission to activities (tasks). Then, attributes are identified for each task and measures are determined based on these task attributes. Note that there is an additional identification of joint (and possibly Service) tasks from published task lists and a listing of measures from those published lists. It is assumed that the documented measures in the task lists will not be sufficient for measuring all of the tasks in a JMT. However, some of the measures will be useful, so identifying possible measures from the task lists becomes part of the process for developing task measures.

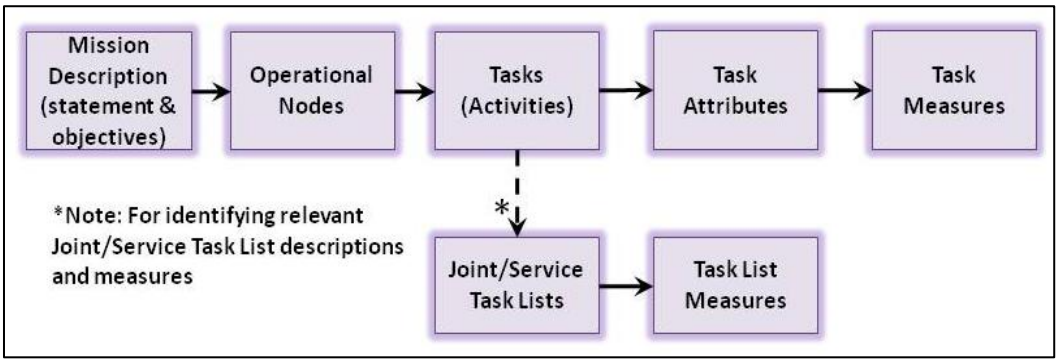

Figure 2-7. Task Decomposition Flow

Element Descriptions

- **Mission Description**. The mission description developed in Step 1 provides the basis for decomposing mission to tasks.
- **Operational Nodes**. The operational nodes are functional nodes used to perform the mission. The key nodes should be shown in the OV-1 and identified by a functional title that is not system specific. For example, an operational node may be shown as a "strike aircraft." Identifying the node as an "F/A-18" would be incorrect in a mission analysis.
- **Tasks**. A task is an action or activity. (For reference, DoDAF 2.0 uses the single term "activity.") Tasks can be decomposed to multiple levels as needed (tasks → sub-tasks → sub-sub-tasks).
- **Joint/Service Task Lists**. The UJTL is a documented list of joint tasks. Each Service also develops task lists to document Service-specific tasks. Although Service tasks may imply Service-specific systems (especially at the mission strand/Tier 2/3 level), they may be useful and provide additional information while developing higher-level task measures based on a JMT Tier 1. In any case, the intent is to identify those Service tasks that are relevant to the mission.

- **Task List Measures**. The joint and Service task lists also provide measures with each task. The measures can provide a basis for developing the JMT task measures, but they are not assumed to be complete and sufficient. The intent is to identify and list those task measures for possible use.
- **Task Attributes**. Just like mission effects, attributes can be identified for tasks. The attributes will identify how well the task is performed.
- **Task Measures**. Each task will have associated measures with which to evaluate an attribute. These measures should provide the basis for meeting warfighter requirements for performing tasks. The measures will be referred to as "task measures."

> **Every task has multiple dimensions of performance that can be observed and the criteria to specify an acceptable level of performance for each dimension. At a minimum, most tasks can be measured in terms of the time required to initiate or to complete a task (that is, response time), the rate at which progress is being made (for example, rate of movement), an overall level of completion or success (for example, of fires to target) in terms of power (for example, engagement range), lethality (for example, rate transmitted). Key dimensions of task performance should be found in the commander's guidance and concept of operations.** CJCSM 3500.04E, Appendix B, Enclosure B, Page 4

Process

The Step 2 task decomposition process begins with an overall picture of the mission. Key operational nodes must be identified as the "means" to performing the tasks. Tasks may also be decomposed to multiple levels of detail, such as can be found, for example, in a JMT Tier 1 OV-5b. Relevant joint and Service tasks can be determined along with their documented measures as a possible source of mission task measures. The Step 2 process is completed with the identification of task attributes and measures. Figure 2-8 illustrates this process as a series of matrices that supports the traceability of task measures back to the mission objectives. Similar to Step 1, each matrix is intended to map relationships between the rows and columns.

Operational Viewpoint One (OV-1)

Mission Description – Operational Nodes

The mission description and operational nodes are shown as an OV-1 product. A standard OV-1 provides a pictorial representation of the environment and the systems that will perform in that environment. In a JMT Tier 1, for example, those systems should be represented as operational nodes (not system specific). To provide the linkage between mission, tasks, and operational nodes, additional information is necessary to make the connections. Figure 2-9 shows an example of an expanded OV-1 which provides mission and task information based on the JPR mission thread. Note that this expanded OV-1 provides the mission description information

(statement and objectives). This format also provides the mission desired effects and the high level tasks that comprise the mission thread. All other tasks will be subordinate to one of these high level tasks. This OV-1 representation of the mission provides several components of the capability definition (means, task, and effects).

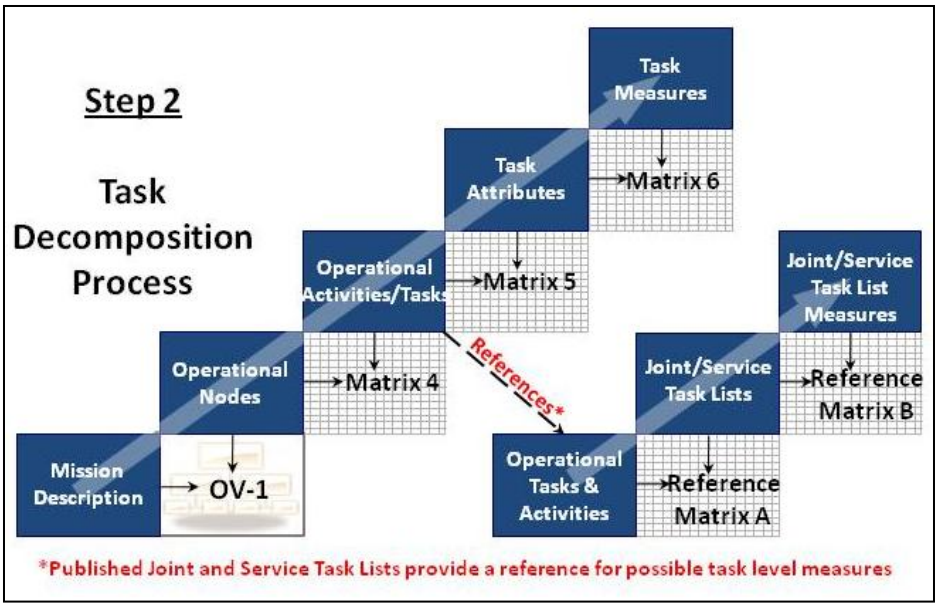

Figure 2-8. Task Decomposition Process

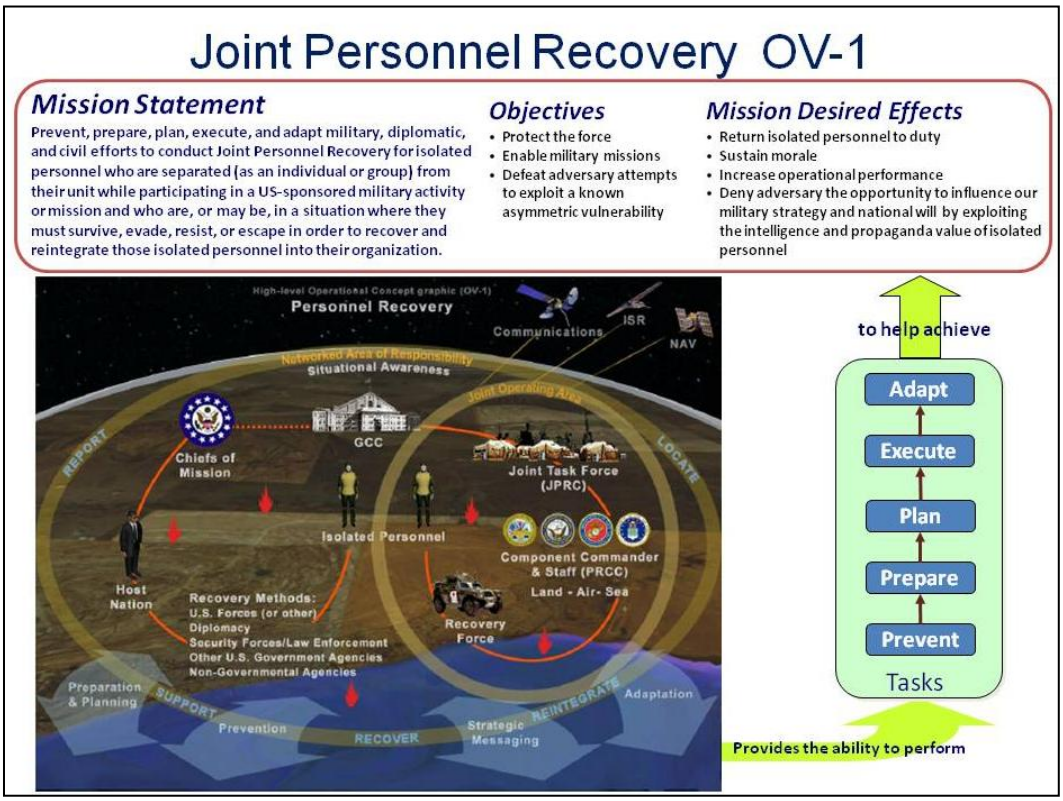

Figure 2-9. Joint Personnel Recovery OV-1

Matrix 4: Operational Nodes - Tasks

The OV-1 provides a high level view of the operational nodes and tasks. This part of the process develops a matrix that maps the operational nodes to operational activities (tasks). It requires a decomposition of activities and an understanding of which nodes performs what activities. The resulting matrix will provide insights into possible interactions that may occur between nodes. The set of OV-2 products may be the best source for this information. (See figure 2-10.)

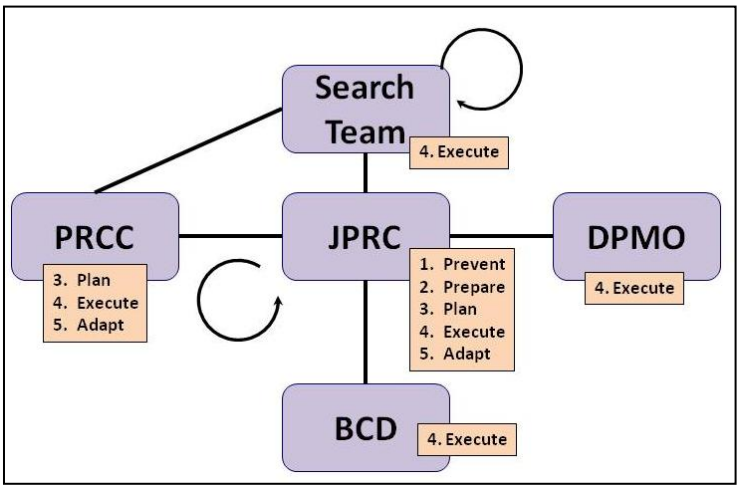

Figure 2-10. Joint Personnel Recovery OV-2

Since tasks can be decomposed into multiple subordinate layers, there may be a need to develop more than one matrix to fully represent all mapping of nodes to tasks. The first matrix may be a mapping at the highest level of tasks.

Figure 2-11 provides a template for a high level matrix that maps nodes to tasks. Additionally, the figure shows how subordinate tasks can be mapped to nodes. The level of detail will depend on the levels of tasks found in the OV-2s. There is no real guideline for determining where to stop the mapping process. Potentially, every task and subordinate task identified during mission analysis may require mapping to nodes.

General Guidelines for Determining Matrix 4 Relationships

- Use JMT Tier 1 products (if available) to produce the matrix.
- Use operational nodes and not specific systems.
- Map tasks to operational nodes.
- Continue to map subordinate tasks to operational nodes as needed. When all the subordinate tasks have the same nodes mapped to them, stop decomposing that task.
- In a task parent – child relationship, if a node is mapped to a child task (subordinate), then that node must also be mapped to the parent task.

Operational Node	Task	Task 1	Task 2	Task 3			Task 4
				Task 3.1	Task 3.2	Task 3.3	
Node 1		X	X	X	X	X	X
Node 2			X	X	X	X	
Node 3			X	X	X		X
Node 4						X	X
Node 5							X

Figure 2-11. Matrix 4 Example Format

Reference Matrix A: Task Lists

This part of the process is optional, but the purpose is to provide additional documentation of tasks that enable the development of task measures to support a JMT. It recognizes joint and Service task lists as authoritative sources of information. Joint and Service tasks that are linked to operational activities (tasks) found in Matrix 4 may be documented as Reference Matrix A. The UJTL and each Service (Army, Marine Corps, Navy, and Air Force) may be found in the Joint Doctrine, Education, and Training Electronic Information System web portal, although the Air Force does not currently publish a formal task list.

The process for developing this reference matrix is simple. Note that the JMT itself originates from a joint task. The joint task description will contain a list of relevant joint and Service tasks. Mapping that list of tasks to the activities from Matrix 4 will provide a majority of the relevant tasks. A quick review of the task lists may enable finding additional tasks that are relevant to the JMT. Figure 2-12 illustrates a template for Reference Matrix A.

JMT Operational Activities (Tasks)	Joint (J) or Service Task	Task Number	Task Title
Task 1	J	TA x.x	Execute Operations
Task 2	Army	ART x.x	Execute Army Operations
Task 3			
Task 4			

Figure 2-12. Reference Matrix A Example Format

General Guidelines for Producing Reference Matrix A

- Start with the primary joint task on which the JMT is based (for example, JPR JMT is based on TA 6.2: Execute Personnel Recovery Operations).
- Determine which supporting joint and Service tasks listed in the primary joint task can be mapped to sub-tasks in the JMT.
- Focus mostly on operational and tactical tasks, as strategic national and strategic theater tasks will probably not help in identifying JMT task measures.
- Consider supporting tasks listed in other relevant joint tasks as possible tasks to include in the matrix.
- When in doubt on listing a task, do it. It may produce good measures.

Reference Matrix B: Task List Measures

The list of joint and Service tasks from Reference Matrix A will support a listing of task measures that can be documented in a Reference Matrix B. Keep in mind that this matrix is used as a reference for later development of Matrix 6 to determine JMT task measures. The quantity and quality of the task-list measures vary, so this will not provide the complete solution to determining task measures for the JMT.

To develop Reference Matrix B, list the measures found in the relevant joint and Service task lists. In some cases, common measures will exist across different tasks. When possible, eliminate duplicates in the list of measures and map to each relevant task. Again, note that this list is for future reference and does not constitute the final list of task measures that will support the JMT. Since the list of measures will probably be longer than the list of joint/Service tasks, it may be easier to construct a matrix with measures as rows and tasks as columns. Figure 2-13 provides an example template.

Scale	Measure	Joint/Service Tasks	Execute Operations 1	Execute Operations 2	Execute Operations 3
			TA x.x	OP x.x	ART x.x
%	Measure 1		X	X	X
Min	Measure 2		X	X	
Yrds	Measure 3			X	
%	Measure 4				X

Figure 2-13. Reference Matrix B Example Format

General Guidelines for Producing Reference Matrix B

- List measures documented in each joint and Service task identified in Reference Matrix A.
- Eliminate duplicate measures when they exist, but maintain mapping to relevant JMT tasks.

Matrix 5: Operational Tasks - Attributes

The next part of the process supports actual development of task measures. Similar to determining attributes at the mission level, task attributes must be determined. Matrix 5 will support the process to identify and map attributes to the tasks. Recalling that an attribute is defined as "a quantitative or qualitative characteristic of an element or its actions," the purpose is to characterize an "action" (that is, task performance). The desired performance may be described in warfighter requirements, or it may be a part of the task description. In either case, certain attributes should be identified that will support development of task measures.

Task attributes should characterize the task, not the "means and ways."

Task attributes must characterize the task, and not the means and ways. When considering an attribute, ask the question, "Does the task need to be (insert the attribute), or does the SoS need to be (insert the attribute)?" If the answer is the task, then it can be considered a task

attribute. Using the attribute of timeliness as an example, ask the question, "Does the task need to be (timely), or does the SoS need to be (timely)?" In this case, they both need to be timely, that is, the SoS (means) must function in a timely manner in order to perform the task in a timely manner. A second example uses the attribute of "redundancy." Asking the same question, "Does the task need to be (redundant), or does the SoS need to be (redundant)?" would lead to the conclusion that the task does not need to be redundant, but that having redundant systems could be beneficial. The process for identifying task attributes may require understanding the purpose of the task. Developing a written description of the task will aid in the identification process. Figure 2-14 provides an example template for Matrix 5. Each task and sub-task should have an identification number, title, and a short description. JMT Tier 1 documentation (if available) may include a task description, or the developer may need to refer to other sources, such as joint doctrine.

JMT Operational Tasks			Attributes	Attribute 1	Attribute 2	Attribute 3	Attribute 4
#	Title	Description					
1.0	Task Title 1.0	Task description 1.0		X	X	X	
1.1	Sub-Task Title 1.1	Sub-Task description 1.1		X			
1.2	Sub-Task Title 1.2	Sub-Task description 1.2			X	X	
1.3	Sub-Task Title 1.3	Sub-Task description 1.3		X	X		
2.0	Task Title 2.0	Task description 2.0				X	X

Figure 2-14. Matrix 5 Example Format

Some Common Task Attributes

- **Timeliness**: The time required to initiate or to complete a task (that is, response time)
- **Effectiveness**: The rate at which progress is being made in a task (for example, rate of movement)
- **Completion**: An overall level of completion or success with a task (that is, of fires to target) in terms of power (for example, engagement range)
- **Lethality**: The rate of kill in a task (for example, Pk)
- **Accuracy**: The degree of precision in a task

General Guidelines for Producing Matrix 5

- Review warfighter requirements for task performance attributes.
- Ask the question, "Does the warfighter need this task to be (insert the attribute)?" to verify if the attribute is appropriate to evaluating the task.
- Review related joint and Service tasks listed in Reference Matrix "B" for relevant attributes.
- Consider the commonly used task attributes.
- Develop task descriptions from JMT products and joint doctrine. Use to identify potential task attributes.
- Ensure there is at least one attribute for each task.
- Attributes mapped to sub-tasks should also map to the parent task.

Matrix 6: Task Attributes – Task Measures

The last part of the task measures development process is constructing Matrix 6 with task attributes and task measures. This requires development of at least one measure for each attribute-task pairing in Matrix 5. Often, more than one measure may be required. The writing of measures should follow the guidance provided in chapter 1. The focus is on measuring how well the task is performed. Some measures may come directly from the joint and Service task lists provided in Reference Matrix B. Figure 2-15 provides an example template for Matrix 6.

General Guidelines for Producing Matrix 6

- Write measures utilizing the guidance provided in chapter 1.
- Use established measures from task lists only when appropriate.
- There should be at least one measure identified for each attribute.
- Determine a scale and description for each measure.
- Measures may span numerous levels of tasks. For example, a measure of timeliness for a sub-task may also require a measure of timeliness for the parent task.
- A short list of measures is often better than a long list of measures; however, it is important to accurately cover the measurable attributes of the task.

JMT Operational Tasks		Attributes	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Measures		
#	Title						#	Scale	Measure description
1.0	Task Title 1.0		X	X	X				
			X				TM1	%	Of task…
				X			TM2	Min	For task…
					X		TM3	Ct	Of task…
1.1	Sub-Task Title 1.1		X						
			X				TM4	%	Of task…

Figure 2-15. Matrix 6 Example Format

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CHAPTER 3
MISSION AND TASK MEASURES DEVELOPMENT EXAMPLE

Step 1: OVERVIEW AND EXAMPLE

This section provides an example of the Step 1 process using the JPR JMT. As of the date of this SOP, most of the DoDAF artifacts for the JPR Tier 1 JMT existed in draft form. This example refers to those artifacts as needed. Recognize that Step 1 measures development may occur simultaneously with the development of JMT Tier 1 artifacts, so it will be normal to utilize draft DoDAF artifacts during the measures development process.

Matrix 1: Mission Description – Desired Effects

Based on DoDAF 2.0, an AV-1, Overview and Summary Information, should contain (among other elements) a mission statement, mission objectives, or effects.[18] However, the OV-1 description for the JPR JMT contains the following statement[19]:

> **"The overarching purpose of the personnel recovery concept is to protect the force, enable military missions, and defeat adversary attempts to exploit a known asymmetric vulnerability."**

This purpose statement will be used as the basis for the mission objectives. What is not found are "effects." Therefore, the best alternate source of information is JP 3-50, *Personnel Recovery*. The executive summary is a good starting point for finding mission description information:

> **Personnel recovery is the sum of military, diplomatic, and civil efforts to affect the recovery and reintegration of isolated personnel. Isolated personnel are United States (US) military, DoD civilians, DoD contractors, and others designated by the President or Secretary of Defense who are separated (as an individual or group) from their unit while participating in a US-sponsored military activity or mission and who are, or may be, in a situation where they must survive, evade, resist, or escape.**
>
> **Personnel recovery is a system in which the objectives are to return isolated personnel to duty, sustain morale, increase operational performance, and deny adversaries the opportunity to influence our military strategy and national will by exploiting the intelligence and propaganda value of isolated personnel.** JP 3-50

Although the second paragraph refers to objectives, the listed items are desired effects. After listing the objectives and desired effects from these authoritative descriptions and then relating them in a matrix, construct Matrix 1 (figure 3-1). As a check on the mission description, if there is no desired effect for a mission objective, go back and look for it. Ultimately, on the mission level, the goal is to measure attributes of desired effects.

Mission statement:

Prevent, prepare, plan, execute, and adapt military, diplomatic, and civil efforts to conduct Joint Personnel Recovery for isolated personnel who are separated (as an individual or group) from their unit while participating in a US-sponsored military activity or mission and who are, or may be, in a situation where they must survive, evade, resist, or escape in order to recover and reintegrate those isolated personnel into their organization. (JP3-50)

Objectives	Desired Effects	Return isolated personnel to duty (JP3-50, pg ix)	Sustain morale (JP3-50, pg ix)	Increase operational performance (JP3-50, pg ix)	Deny adversary the opportunity to influence our military strategy and national will by exploiting the intelligence and propaganda value of isolated personnel (JP3-50, pg ix)
Protect the force (JPR JMT Annex 2, pg 82)		X	X		
Enable military missions (JPR JMT Annex 2, pg 82)		X	X	X	
Defeat adversary attempts to exploit a known asymmetric vulnerability (JPR JMT Annex 2, pg 82)		X			X

Figure 3-1. Matrix 1 Example - JPR JMT

Matrix 2: Desired Effects – Mission Attributes

Determining mission attributes can be one of the most difficult tasks in this process. However, a careful evaluation of the meaning of each effect can help to identify appropriate attributes. Keep in mind that the effect is an output of the mission; so, when the effect is evaluated, it is the end result which must be measured. The importance of this concept will become evident in this example.

DE1: Return Isolated Personnel to Duty

With each desired effect, it is helpful to first categorize the type of effect as physical or behavioral. DE1 may be categorized as a change in the physical state of a system. The system in this instance is the IP. The state change is for the IP to go from an "isolated" state to a "ready

for duty" state. So what does it mean to "return the IP to duty?" (JP 3-50 describes the requirements for this desired effect.)

> **Before recovered isolated personnel can be returned to duty they must be medically cleared, complete a survival, evasion, resistance, and escape (SERE) /intelligence debrief, and have some form of decompression.** JP 3-50, Page VI-33

The statement first uses a modifier "recovered" when referring to the IP. Therefore "recovered" is a condition to being returned to duty. The activities "medically cleared," "complete debrief," and "decompression" determine whether the recovered IP can be returned to duty and how long it will take (in terms of processes to be completed). Possible attributes for this desired effect are "cleared," "debriefed," and "decompressed." These attributes modify the phrase "return to duty." The primary modifier is "cleared" since the other prerequisites need to be accomplished to be cleared (that is, the desired effect will not be sensitive to these attributes).

Alternative adjectives could be "available" or "qualified." Both modifiers imply the three prerequisites and the additional phrase "for duty." The term "availability" is usually considered a standard of suitability when applied to the acquisition of a materiel system. However, in this case the system is not under acquisition and not considered a standard of suitability, but a change of state. The military's processes of qualifying personnel may facilitate the use of the "qualified" attribute. Qualified requires that someone be "fit for duty," both mentally and physically, and trained. Since the JPR JMT does not address retraining, use of "qualified" as an attribute may be too broad and result in an additional measure not intended to meet the desired effect. The actual attribute chosen may be subject to some interpretation of intent from the originator of the desired effect and impact the construct of measures. Therefore, care must be observed in attribute selection.

In the DE1 example, "availability" was selected as the most appropriate attribute, as it requires the "recovered" and "cleared" conditions for the IP to be available for duty. "Availability" must be defined in terms of "recovered" and "cleared" in order to facilitate measures development in Matrix 3.

> **"Availability" is the degree to which the IP is recovered, medically cleared, and ready to perform normal duties.**

DE2: Sustain Morale

DE2 may be categorized as a change in behavioral state of a system or as a change in behavior. Since there is no indication as to whose morale needs to be sustained, this may need to be determined. If referring to the morale of the IP, then a change in behavioral state of the system is being effected. If it is about the morale of mission participants and/or other personnel, then this may refer to a change in behavior because it may impact the selection of attributes for this effect. It is also important to recognize that the verb "sustain" implies the behavior change is maintained over a period of time (in this case, the entire mission) and that the desire is not for a change in morale to the negative. (JP 3-50 describes the need for this desired effect and how to achieve it.)

All interaction with the IP should consider the need to establish, maintain, and enhance their positive attitude. A high morale enhances the IP's ability to focus on proper application of their knowledge and skills to survive, evade, resist, and escape. JP 3-50, Page VI-13

This description defines "sustain" to mean "establish, maintain, and enhance" morale. It also indicates the intent is to sustain morale of the IP in order to focus their ability to survive, evade, resist, and escape. Thus, sustaining morale is an enabler to the IP in order to be able to respond to adverse situations. Therefore, "responsiveness" is selected as the key attribute for DE2. A definition is provided to aid in constructing measures in Matrix 3.

"Responsiveness" describes how ably and quickly the IP can react to situations to survive, evade, resist, and escape capture.

DE3: Increase Operational Performance

DE3 may be categorized as a result, outcome, or consequence of an action. In terms of increasing performance of a mission, one would normally consider how to increase the performance of humans and their interactions. To further understand what is meant by the desire to "increase operational performance," a search of JP 3-50 offers some clues that may help. The first statement considers coordination as a key to operational performance. The second statement implies the need for situational awareness in order to task appropriate action. Thus, two attributes are considered for DE3, "coordination" and "awareness." A definition of each is provided to aid in constructing measures in Matrix 3.

- **"Coordination" is a key element for successful prosecution of PR missions.** JP 3-50, Page xiii
- **In personnel recovery, success is far more likely if the people involved are properly organized, trained, equipped, and employed to gain and maintain the ability to process relevant information (situational awareness) and to take appropriate action.** JP 3-50, Page x

"Coordination" is the degree to which JPR operational nodes conduct continuous vertical and horizontal integration of activities that increase operational performance by reducing redundancy and creating synergy.

"Awareness" is the degree to which JPR operational nodes gain and maintain the ability to process relevant information and to take appropriate action.

DE4: Deny Adversary Exploiting Isolated Personnel

DE4 may be categorized as an effect that denies a change in degree of freedom. The desire is to remove this dimension from the battlespace. The JP 3-50 definition may lead to the conclusion that the intent is to deny the enemy the ability to influence military strategy and national will, or US willingness to act against the enemy. The JPR JMT Tier 1 description includes "Prevent" as a major task for the mission thread. It defines the task as, "The US government will **prevent**

> **Deny adversaries the opportunity to influence our military strategy and national will by exploiting the intelligence and propaganda value of isolated personnel.**
> (JP 3-50, Page ix)

isolation of US Citizens through planning, training, and unity of effort to decrease individual and collective vulnerability." Planning and training are characteristics of a "readiness" attribute, while unity of effort is a characteristic of the "coordination" attribute. A definition of "readiness" is provided to aid in constructing measures in Matrix 3.

> **"Readiness" is the state of preparedness of JPR operational nodes to meet the JPR mission. It is based on adequate and trained personnel, material condition, supplies/reserves of support system and ammunition, numbers of units available, and so forth.**

Figure 3-2 provides the resultant Matrix 2 of desired effects and attributes. Note that more than one attribute may be needed for a desired effect. Also, the definition of each attribute is not shown in the matrix, but will be important in the development of measures in the next part of the process.

#	Desired Effects	Attributes	Availability	Responsiveness	Coordination	Awareness	Readiness
DE1	Return isolated personnel to duty (JP3-50, pg ix)		X				
DE2	Sustain morale (JP3-50, pg ix)			X			
DE3	Increase operational performance				X	X	
DE4	Deny adversary opportunity to exploit the IP (JP3-50, pg ix)				X		X

Figure 3-2. Matrix 2 Example – JPR JMT

Matrix 3: Mission Attributes – Mission Measures

Mission measures are aimed at the attributes of the desired effects. The measures must be able to assess mission impact on the desired effect. Remember that the desired effect is intended to demonstrate the achievement of an objective or end state, so the measure must apply to the objective and/or the end state. The attribute definitions determined in the last part of the process will help in the development process. Recall that each measure must have a scale and description, so the end product of each measure must have both components.

As stated in chapter 1, measures support many communities of interest. Some situations may occur where limited resources could make it difficult to assess certain mission level measures. Matrix 3 will focus on developing mission level measures; however, qualitative critical issues will also be offered as an alternative to the quantitative measures.

Availability Attribute

The "availability" attribute is tied to DE1 (Return IP to Duty) and all three mission objectives. The definition of "availability" provided in Matrix 2 development indicates a need to measure the status of the IP as recovered, medically cleared, and ready to perform normal duties. As stated, medically cleared is the key to this attribute. Thus, the best measure is whether the IP was medically cleared. Given this measure includes numerous instantiations of the JPR mission thread, an appropriate measure would be, "Percent of JPR missions where IP was cleared for duty." However, since recovery is a precondition to being medically cleared, a second measure to consider would be, "Percent of JPR mission where IP was available to be cleared for duty." A critical issue for this attribute may be written as, "Assess the ability to recover and clear the IP for duty."

Responsiveness Attribute

The "responsiveness" attribute is tied to DE2 (Sustain Morale) and two of the three mission objectives (Protect the Force and Enable Military Missions). The definition of "responsiveness" given in Matrix 2 development is in terms of how ably and quickly the IP can react to certain situations. "Quickly" implies the need to measure time (how quick). One measure could be written as, "Time for IP to respond to changes in conditions that require the IP to react." Adding clarity to specify types of changes in the conditions and what type of reactions the IP could take would then produce a more well-defined measure written as, "Time for IP to respond to changes in the threat and environment conditions that require the IP to evade, resist, or escape." A second measure could be written to more directly account for the affect of morale on responsiveness. In assessing mission failures, it could be worthwhile to know where morale was a negative factor. A measure could be written as, "Percent of JPR missions where morale was a factor in IP inability to survive, evade, resist, or escape." A critical issue for this attribute may be written as, "Assess the ability to maintain morale of the IP."

NOTE: While this is not a measure that would be testable during the acquisition process or even in a training scenario, it may be an area for operational analysis during or after a contingency operation.

Coordination Attribute

The "coordination" attribute is tied to DE3 and DE4 (Increase Operational Performance and Deny Adversary Opportunity to Exploit IP) and the last two mission objectives (Enable Military Missions and Defeat Adversary Attempts to Exploit). The definition of "coordination" used in developing Matrix 2 applies to vertical and horizontal coordination across all operational nodes in the JPR JMT. "Continuous" implies the need to always be coordinated. The intent is to reduce redundancy and to create synergy in order to increase operational performance. "Redundancy" can be assessed by measuring if redundant actions occurred. A measure may be written as, "Percent of JPR missions where no unplanned redundant activities occurred." "Synergy" may be more difficult to measure, as it may be best to assume synergy will occur if coordination occurs. Measures may be written for both vertical and horizontal coordination as, "Percent of JPR mission where continuous horizontal coordination existed across operational nodes." Coordination in planning and preparation is also required to deny the adversary the ability to exploit IP. Thus, a measure may be written as, "Percent of JPR mission executions where planning and preparation led to successful coordination across operational nodes." A critical issue for this attribute could read, "Assess the ability to coordinate JPR missions across operational nodes that reduces redundancy and creates synergy."

Awareness Attribute

The "awareness" attribute is tied to DE3 (Increase Operational Performance) and the second mission objective (Enable Military Missions). The definition of "awareness" given in Matrix 2 development indicates the need for operational nodes to gain and maintain situational awareness in order to process relevant information and to take appropriate action. Measures can be written to assess processing information correctly and taking appropriate action. One possible measure is, "Percent of JPR missions where correct decisions were made by operational nodes based on situational awareness." A second measure may be written as, "Percent of JPR missions where operational nodes acted correctly based on situational awareness." And a third measure could be written to apply to the IP taking correct actions. A critical issue for this attribute may be written as, "Assess the ability to maintain situational awareness across all operational nodes in order process relevant information and take appropriate actions."

Readiness Attribute

The "readiness" attribute is tied to DE4 (Deny Adversary Opportunity to Exploit IP) and the third mission objective (Defeat Adversary Attempts to Exploit). The definition of "readiness" in Matrix 2 development implies that "readiness is a state of preparedness." This is derived from the Defense Acquisition University (DAU) Glossary definition, "Readiness is based on adequate and trained personnel, materiel condition, supplies/reserves of support system and ammunition, numbers of units available, etc."[20] Readiness measures will be focused mostly on the planning and preparation phases impact on the JPR execution phase. A measure may be written as, "Percent of JPR missions where inadequate training led to mission execution deficiencies." Then a second measure can be written to apply to resource deficiencies. A critical issue for this

attribute may be written as, "Assess the ability to maintain a state of preparedness for conducting JPR missions."

Matrix 3 Example – Mission Attributes and Mission Measures

Figure 3-3 provides the resultant Matrix 3 of mission attributes and mission measures. Note that although critical issues were developed in the discussion to this section, none are shown in Matrix 3. Figure 3-4 provides a sample mapping of critical issues to measures and attributes.

#	Scale	Mission Measures (MM)	Attributes	Availability	Responsiveness	Coordination	Awareness	Readiness
MM-1	Percent	Of JPR missions where IP personnel was available to be cleared for duty		X				
MM-2	Percent	Of JPR missions where IP personnel was cleared for duty		X				
MM-3	Time	For IP to respond to changes in threat and environmental conditions that required the IP to evade, resist, or escape			X			
MM-4	Percent	Of JPR missions where morale was a factor in IP inability to survive, evade, resist, or escape			X			
MM-5	Percent	Of JPR missions where no unplanned redundant activities occurred				X		
MM-6	Percent	Of JPR missions where continuous horizontal coordination existed across operational nodes				X		
MM-7	Percent	Of JPR missions where continuous vertical coordination existed across operational nodes				X		
MM-8	Percent	Of JPR mission executions where planning and preparation led to successful coordination across operational nodes				X		
MM-9	Percent	Of JPR missions where correct decisions were made by operational nodes based on situational awareness					X	
MM-10	Percent	Of JPR missions where IP acted correctly based on situational awareness					X	
MM-11	Percent	Of JPR missions where operational nodes acted correctly based on situational awareness					X	
MM-12	Percent	Of JPR missions where inadequate training led to mission execution deficiencies						X
MM-13	Percent	Of JPR missions where inadequate systems, supplies, and resources led to mission execution deficiencies						X

Figure 3-3. Matrix 3 Example – JPR JMT

Attribute	CCI #	Critical Capability Issue (mission)	Measure #
Availability	1	Assess the ability to recover and clear the IP for duty	MM-1
			MM-2
Responsiveness	2	Assess the ability to maintain morale of the IP	MM-3
			MM-4
Coordination	3	Assess the ability to coordinate JPR missions across operational nodes that reduces redundancy and creates synergy	MM-5
			MM-6
			MM-7
			MM-8
Awareness	4	Assess the ability to maintain situational awareness across all operational nodes	MM-9
			MM-10
			MM-11
Readiness	5	Assess the ability to maintain a state of preparedness for conducting JPR missions	MM-12
			MM-13

Figure 3-4. Mission Critical Issues – JPR JMT

Step 2: OVERVIEW AND EXAMPLE

This section provides an example of the Step 2 process for developing JMT task measures using the JPR JMT. As of the date of this SOP, most of the DoDAF 2.0 artifacts for the JPR Tier 1 JMT existed in draft form. This example will refer to those artifacts as needed. The OV-1 shown in figure 2-9 will provide the basis for developing the Step 2 set of matrices in this example. It is based on the five major task levels of the JPR JMT: prevent, prepare, plan, execute, and adapt. Since the development process and list of measures for each task and sub-task can be extensive, this example will concentrate on the sub-task of **Locate**, under the parent task of **Execute**.

Matrix 4: Operational Nodes - Tasks

Matrix 4 maps operational nodes to activities (tasks). The decomposition of tasks to subordinate tasks should be found in the JMT Tier 1 OV-5b artifacts (figure 3-5). This will provide the necessary data to determine the Matrix 4 columns. The set of operational nodes should be found in the JMT Tier 1 OV-1 product. However, to determine what subset of operational nodes applies to the Locate sub-task, refer to the JMT Tier 1 OV-2 artifacts (figure 3-6). In this example, there are five operational nodes that form the SoS to perform the **Locate** sub-task.

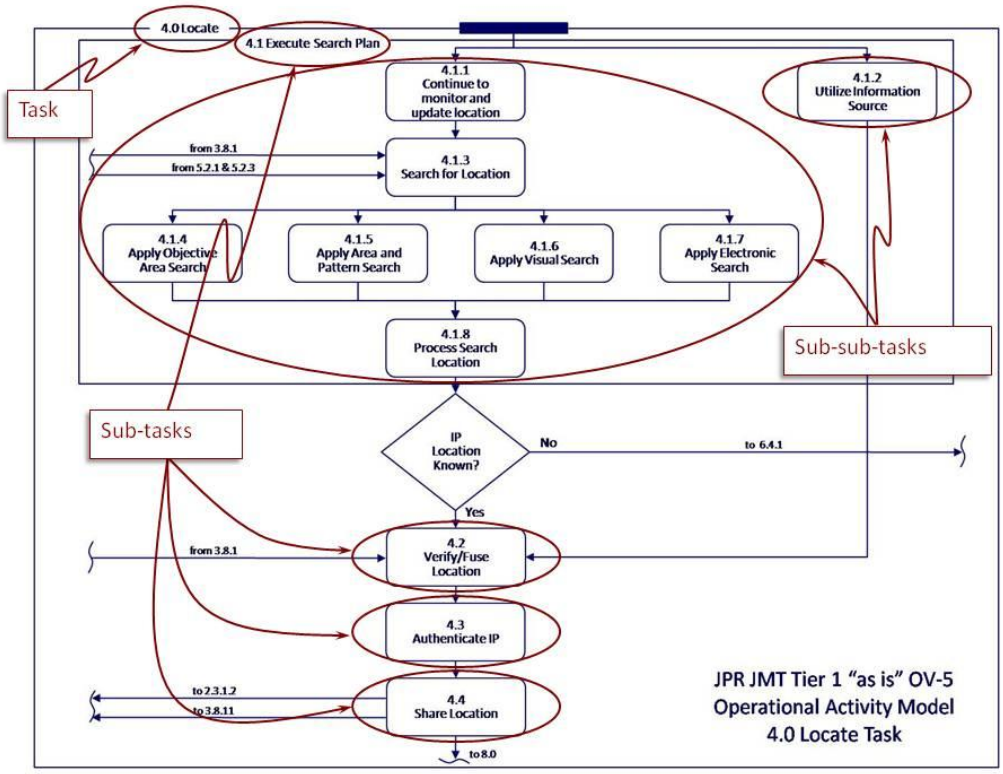

Figure 3-5. JPR Tier 1 OV-5b for 4.0 Locate Task

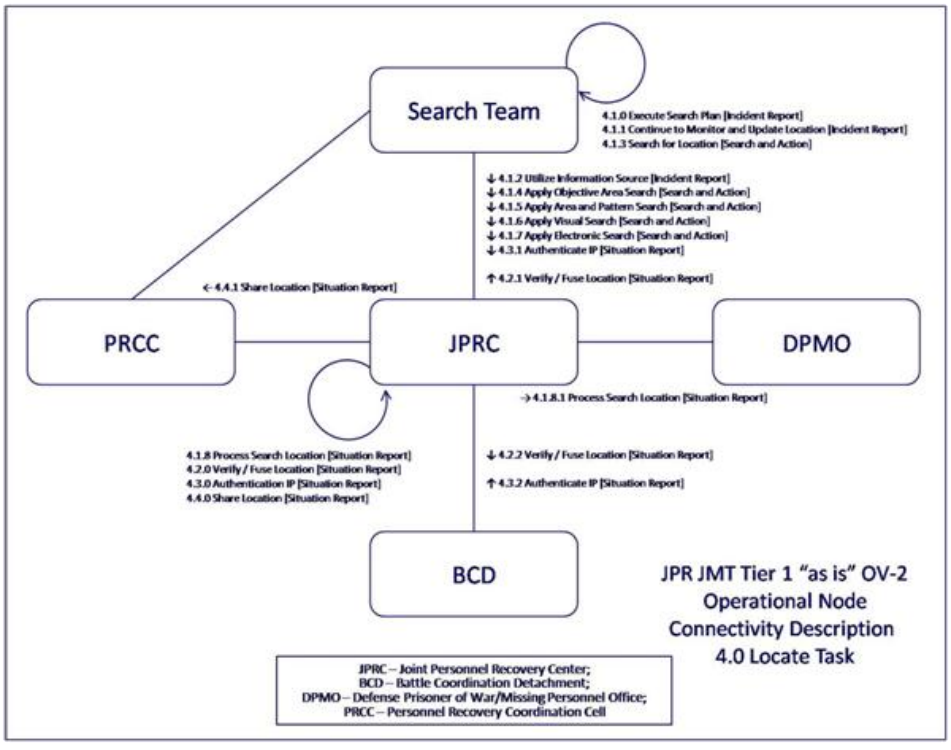

Figure 3-6. JPR Tier 1 OV-2 for 4.0 Locate Task

Also found in the OV-2 are the sub-sub-tasks under the Locate sub-task. This will provide the information needed to do the mapping between nodes and tasks. Figure 3-7 is the example Matrix 4 for the JPR JMT.

Task #	Operational Tasks/Activities	Joint Personnel Recovery Center (JPRC)	Personnel Recovery Coordination Center (PRCC)	Battle Coordination Detachment	Search Team	Defense POW/ Mission Personnel Office (DPMO)
4.0	Locate	X	X	X	X	X
4.1	Execute Search Plan	X			X	X
4.1.1	Continue to Monitor and Update Location				X	
4.1.2	Utilize Information Source	X			X	
4.1.3	Search for Location				X	
4.1.4	Apply Objective Area Search	X			X	
4.1.5	Apply Area and Pattern Search	X			X	
4.1.6	Apply Visual Search	X			X	
4.1.7	Apply Electronic Search	X			X	
4.1.8	Process Search Location	X				X
4.2	Verify/Fuse Location	X		X		
4.3	Authenticate IP	X		X	X	
4.4	Share Location	X	X			

Figure 3-7. Matrix 4 Example – JPR JMT

Reference Matrix A: Task Lists

This part of the process identifies relevant joint and Service tasks that may be used as reference material for development of task level measures. Reference Matrix A leverages the measures that already exist in the documented task lists. Begin this process by identifying the primary joint task on which the JMT is based. This should be obvious from the JMT documentation. For JPR, the primary joint task is TA 6.2, Execute Personnel Recovery Operations, a tactical (TA) level joint task. Since this task is at the tactical level, expect to find at least one relevant joint task at the operational level. Referring to the documentation for TA 6.2 produces a long list of supporting tasks. "Supporting" is the key word here. Most will not help identify JPR task measures, as they are not directly related to JPR. A joint operational (OP) level task, OP 6.2.9, Coordinate Personnel Recovery, will probably offer some good task measures. Since this example focuses on the **Locate** sub-task, this is where the relevant Service tasks are located. In this case, two Air Force tasks, two Navy tasks, and one Marine Corps tasks were found that appear relevant to JPR **Locate**. See figure 3-8 for the resultant reference matrix.

Task #	Operational Tasks/Activities	Joint (J) or Service Task	Task Number	Task Title
	Joint Personnel Recovery	J	TA 6.2	Execute Personnel Recovery Operations
		J	OP 6.2.9	Coordinate Personnel Recovery
4.0	Locate			
4.1	Execute Search Plan	AF	AFT 2.3	Provide Combat Search & Rescue (CSAR) Capabilities
		AF	AFT 2.3.1	Perform CSAR Functions
		N	NTA 6.2.2.1	Perform Search and Rescue
		N	NTA 6.2.2.2	Perform Combat Search and Rescue (CSAR)
		MC	MCT 1.3.4.1.3	Provide Aerial Search and Rescue (SAR) Services

Figure 3-8. Reference Matrix A Example – JPR JMT

Reference Matrix B: Task List Measures

Reference Matrix B is constructed from the simple process of listing documented (from Reference Matrix A) joint and Service task measures. In some cases, duplicates will exist across tasks (particularly when similar tasks exist across the Services). When this occurs, the duplicate can be deleted and the remaining measure is mapped to both tasks. Figure 3-9 provides an abbreviated example of Reference Matrix B.

Metric	Joint & Service Task Lists Task Measures	Joint/Service Tasks	Execute Personnel Recovery Operations TA 6.2	Coordinate Personnel Recovery OP 6.2.9	Provide Combat Search and Rescue (CSAR) Capabilities AFT 2.3	Perform CSAR Functions AFT 2.3.1	Perform Search and Rescue NTA 6.2.2.1	Perform Combat Search and Rescue (CSAR) NTA 6.2.2.2	Provide Aerial Search and Rescue (SAR) Services MCT 1.3.4.1.3
Percent	Of isolated personnel able to report their situation/location.		X						
Minutes	To notify higher echelon and parallel commands following initial report of an isolating incident.		X						
Yes/No	PR mission analysis is accomplished and short falls identified and passed to higher headquarters as requirements.			X					
Yes/No	Plans and orders provide clear and sufficient PR guidance to commanders and staffs, forces and potential isolated personnel.			X					
Percent	Of forces organized for the effective prosecution of CSAR.				X				
Percent	Of forces equipped for the effective prosecution of CSAR.				X				
Percent	Of successful CSAR operations.				X	X			
Cost	To perform CSAR functions.					X			
Hours	To reach area of isolated personnel after Go decision						X	X	
Hours	To rescue an aircrew after ejection or bailout						X	X	
Number/ Percent	Of aircrews mission behind enemy lines recovered						X	X	
Number	SAR missions conducted.								X

Figure 3-9. Reference Matrix B Example – JPR JMT

Matrix 5: Operational Tasks - Attributes

This part of the process returns to the tasks to identify relevant task attributes of performance in Matrix 5. For the sake of brevity, this example will focus on only one layer of sub-tasks under **Locate**. Begin the process by developing a clear understanding of each task and sub-task. In doing so, assume the warfighter requirements are addressed in the JPR JMT documentation and task descriptions. A review of the JPR JMT documentation should then provide a description of each task and sub-task.

4.0 "Locate" Task Descriptions

- **4.1 Execute Search Plan**: Determine the location and status of the isolated personnel (precisely find and fast response).
- **4.2 Verify/Fuse Location**: Verify and fuse isolated personnel's location information to provide accurate and reliable coordinates for refining recovery plans. The goal is for latest, most reliable location information.
- **4.3 Authenticate IP**: Authenticate isolated personnel using isolated personnel report (ISOPREP) data and other methods.
- **4.4 Share Location**: Use available information to refine isolated personnel's location with reliable and accurate information.

Task #4.0 Locate

Task #4.1 Execute Search Plan

This sub-task focuses on determining the location and status of the IP. Additional descriptions with such phrases as "precisely find" and "fast response," imply accuracy and timeliness as attributes. Even though these are common task attributes, apply the task-attribute test to verify the need for these attributes.

- **"Does the task need to be accurate?"** How well or precisely the search plan is executed would seem to be important. If not executed as planned, the search team may be looking in the wrong places and the IP may never be located.
- **"Does the task need to be timely?"** To provide a fast response, the search needs to be executed in a timely manner. Accuracy and timeliness are thus rationally determined as required attributes. Other common task attributes to consider are reliability and completion.
- **"Does the task need to be reliable?"** The search hinges on the reliability of the search team (i.e., if they fly over the IPs location, will they detect and locate the IP?), so measuring reliability of the search in terms of how well the search team detects the IP seems to be appropriate.
- **"Does the task need to be complete?"** Maybe not. If the IP was located early in the search, then the search plan was not completed, but it was effective. Therefore, completeness is not an appropriate attribute for this sub-task.

Task #4.2 Verify/Fuse Location
This sub-task is focused on providing a product, that is, coordinated information that is accurate, reliable, and the most current. Apply the task-attribute test to verify the need for these attributes.

- **"Does the task need to be accurate?"** The information needs to be accurate, so the action to verify and fuse data must produce accurate information.
- **"Does the task need to be reliable?"** Again, the information needs to be reliable, but is that an outcome of the task or based on the reliability of the data that is used in the task? Reliability is usually thought of as system reliability and considered as a suitability issue. However, in this case, the issue is information reliability. An argument could be made that the reliability of the information is based on the reliability of the data that feeds the task and also "how well" the data is verified and fused. Thus, the argument would conclude that reliability, specifically information reliability, is an appropriate attribute for this task. The same argument could be made for having the latest information.
- **"Does the task need to be timely?"** In order for the information to be timely, the process of verifying and fusing the data needs to be timely.

Task #4.3 Authenticate IP
This sub-task, as stated in JP 3-50, offers some clues as to possible attributes. "Authentication management" discusses the need to be complete and accurate in order to verify the identity of the IP.

Task #4.4 Share Location
"Share location" is an action to pass accurate and reliable information to the Personnel Recovery Coordination Cell (PRCC). This already assumes the information is accurate and reliable, so the attributes should be focused on the performance of passing the information. Typically, any information exchange task requires an evaluation of timeliness, accuracy, and completeness. That is:

- "Did the task pass the information timely?"
- "Did the task pass the information accurately?"
- "Did the task pass the information completely?"

The attributes of timeliness, accuracy, and completeness will be used for this sub-task. Figure 3-10 shows the resultant Matrix 5 based on an analysis of task attributes.

Task #	Operational Tasks/Activities		Attributes	Accuracy	Timeliness	Information Reliability	Completeness
4.0	Locate			X	X	X	X
4.1	Execute Search Plan	Determine the location and status of the isolated personnel (precisely find; fast response)		X	X	X	
4.2	Verify/Fuse Location	Verify and fuse isolated personnel's location information to provide accurate and reliable coordinates for refining recovery plans. Goal is for latest, most reliable location information.		X	X	X	
4.3	Authenticate IP	Authenticate isolated personnel using ISOPREP data and other methods		X			X
4.4	Share Location	Use available information to refine isolated personnel's location with reliable and accurate information		X	X		X

Figure 3-10. Matrix 5 Example – JPR JMT

Matrix 6: Task Attributes – Task Measures

Matrix 6 involves the determination of measures that are tied to task-attribute pairings. It is usually easier and better to start developing measures with the lower level of sub-tasks, and then consolidate measures up to the parent task. This practice will provide a better understanding of the sub-tasks and their measures before tackling the higher level task. Note that there is no set order of processes for developing the measures. One person may wish to draft measures based on the attributes and then refer to the measures in Reference Matrix B that come from joint and Service task lists to modify and/or add to the draft measures. A second person may wish to do just the opposite. Either is sufficient as long as both sources are considered and checked. The first process will be followed in this example.

Task #4.0 Locate

Task #4.1 Execute Search Plan

The attributes for this sub-task are accuracy, timeliness, and reliability.

- **Accuracy**. The attribute of accuracy for **Execute Search Plan** should focus on how well the search plan was executed. That is, "Was it performed as planned?" Accordingly, the measure would evaluate, for each time the task was performed, whether the search plan was executed accurately. The search does not have to be completed to have been executed

accurately. Once the IP is found, the search may be called off. The point is to measure accuracy of executing the plan until the search is concluded.

- **Timeliness**. The attribute of timeliness for **Execute Search Plan** would focus on how much time it took to commence executing the search. It cannot measure the time of search, as that will vary according to the search pattern and search type. The time to execute search may be based on the difference in time from being tasked to search and actually having the search team execute. A second measure may be considered as the time to locate the IP once the task was begun.
- **Reliability**. The attribute of reliability for **Execute Search Plan** should focus on how reliable the information provided by the search team is determined to be. For example, if the search team did not detect the IP, was that due to the search plan? It may be difficult to measure the reliability directly, but a post-search analysis may provide sufficient data to evaluate the number of times the search team was at the correct location before detecting the IP.

Task #4.2 Verify/Fuse Location

The attributes for this sub-task are accuracy, timeliness, and information reliability.

- **Accuracy**. The attribute of accuracy for this task is based on how well the **Verify and Fuse Information** task was performed. That is, "Was the result accurate to real truth?" The measure needs to evaluate the percentage of times where the information was correctly verified and fused.
- **Timeliness**. The attribute of timeliness for this task should assess the time it takes to execute the task. That is, "How long does it take to verify and fuse the data?" This should be based only on the instances where the result was accurate, ignoring those instances where the task was performed quickly, but poorly.
- **Information Reliability**. The attribute of information reliability will be based on the information itself. To evaluate the information reliability for this task, ensure the processing of the information either maintained the reliability of the information or improved it.

Task #4.3 Authenticate IP

The attributes for this sub-task are accuracy and timeliness.

- **Accuracy**. The attribute of accuracy for this task is based on how accurately the task was performed. To assess this measure, determine the instances of the task where the IP was authenticated and was correct (accurate to real truth).
- **Timeliness**. The attribute of timeliness for this task should assess the time it takes to execute the task. That is, "How much time did it take to share the authentication information?" It may be based only on those instances where the information shared was accurate and complete.

Task #4.4 Share Location

The attributes for this sub-task are accuracy, timeliness, and completeness.

- **Accuracy**. The attribute of accuracy for this task is based on the accuracy of information passed. That is, "How well was the information passed?" The measure should assess the percent of instances where the information received was accurate compared to the information sent.

- **Timeliness**. The attribute of timeliness for this task should assess the time it takes to execute the task (that is, time required to share the location information). It may be based only on those instances where the information shared was accurate and complete.
- **Completeness**. The attribute of completeness for this task is based on the completeness of information that is passed. That is, "How well was the information passed?" The measure should assess the percent of instances where the information received equaled the complete information sent.

Task #4.0 Locate

This is the parent task of sub-tasks 4.1 through 4.4. Accordingly, all the attributes found in those sub-tasks should be assessed in the parent task. The attributes for this task are accuracy, timeliness, information reliability, and completeness.

- **Accuracy**. The attribute of accuracy for this task is based on the overall accuracy of the sub-tasks combined. That is, "Was the search accurately executed and resulted in an IP location that was verified, fused, authenticated, and shared that would enable the next task of **Recovery**?" The key here is to assess the overall **Locate** task performance so the next task of **Recovery** can be executed. The assessment must focus on the final output of the task, the shared information. That is, "Was the shared information accurate?" "Did it represent the real truth?" To assess the accuracy of the overall **Locate** task requires assessing the accuracy of the shared information.
- **Timeliness**. The attribute of timeliness for this task should assess the time it takes to execute the overall task. That is, "How much time did it take to execute the **Locate** task?" It should only be based on those instances where the result of the task was an accurate IP location. A second measure may be needed to assess the percent of instances where the IP was located and the information passed within a threshold value of time.
- **Information Reliability**. The attribute of information reliability will be based on the information itself. To evaluate the information reliability for this task, ensure the information received from the search team is reliable. Also ensure the processing of the information either maintained the reliability of the information or improved it.
- **Completeness**. The attribute of completeness for this task is based on the completeness of information that is passed. That is, "How well was the information passed?" The measure should assess the percent of instances where the information received equaled the complete information sent.

The last item in completing this Matrix is to review Reference Matrix B measures for possible alterations and additions. In review, several of the timeliness measures were appropriate and used in Matrix 6. Figure 3-11 shows the resultant Matrix 6 that is based on an analysis of task attributes and measures.

Task #	Operational Tasks/Activities	Attributes	Accuracy	Timeliness	Information Reliability	Completeness	Task Meassure Number (TM-#)	Scale	Measure
4.0	Locate		X	X	X	X			
						X	TM-1	Percent	Of Locate tasks that located the IP
				X			TM-2	Time	To locate IP
			X				TM-3	Percent	Of instances where shared information on IP location was accurate with ground truth
						X	TM-4	Percent	Of Locate tasks where information shared was complete
				X			TM-5	Percent	Of Locate tasks executed in a timely manner that provided an accurate location
					X		TM-6	Percent	Of Locate tasks that maintained or improved information reliability of the shared information
				X			TM-7	Percent	Of locate tasks that were able to locate isolated personnel within objective timeline
4.1	Execute Search Plan		X	X					
			X				TM-8	Percent	Of instances where search was executed according to plan before the IP was found
				X			TM-9	Time	To commence search from time tasked
					X		TM-10	Count	Of search passes over IP position before IP located
4.2	Verify/Fuse Location		X	X	X				
			X				TM-11	Percent	Of instances where search data was accurately verified and fused with prior data resulting in correct determination
				X			TM-12	Time	For search data to be verified and fused with prior data which result in a correct determination
					X		TM-13	Percent	Of instances where reliability of the data was maintained or improved from the verify and fuse process
4.3	Authenticate IP		X	X					
			X				TM-14	Percent	Of instances where the authentication of the IP to the location was accurate with real truth information
				X			TM-15	Time	To authenticate IP from time first located
4.4	Share Location		X	X		X			
			X				TM-16	Percent	Of shared information exchanges where information received was accurate with what was sent
						X	TM-17	Percent	Of shared information exchanges where information received was complete when compared to what was sent
				X			TM-18	Time	To execute the share location sub-task where information exchange was accurate and complete

Figure 3-11. Matrix 6 Example – JPR JMT

CHAPTER 4
SYSTEM & SYSTEM-OF-SYSTEMS (SoS) MEASURES DEVELOPMENT

OVERVIEW

The measures framework relationships depicted in Figure 1-3, Measures Framework Relationship to Mission, Task, and Systems illustrates that systems and services are the building blocks of a SoS that supports the performance of tasks. Recall that tasks are performed by individuals or organizations, enabled by functioning systems and services. It is those functions in which system and SoS attributes and measures are based on.

System/SoS Attributes

System attributes are contained in approved capability documents, and are typically stated as Key Performance Parameters (KPP), Key System Attributes (KSA), or other system attributes (OSA). SoS attributes may be similar to system attributes, but differ in that they apply across multiple systems. SoS interactions across systems (that is, interoperability, coordination, and so forth) may represent SoS attributes.

This SOP assumes that the JCIDS Analysis of Alternatives (AoA) and other supporting analyses have already identified capability attributes and determined which are KPPs, KSAs, or OSAs.[21] These system/SoS attributes should have been identified during the JCIDS process and documented in the Capability Development Document (CDD) along with associated threshold and objective values.

System/SoS attributes (KPPs, KSAs, and OSAs) may be described in terms of key phrases like "the system shall…" or "the system must be capable of…", or may be derived from other indications that a characteristic cited in the document is required or expected of the system. In some cases, multiple attributes may be derived from a single statement or the attribute itself may only be expressed in terms of a single standard. In other cases, the attribute may not have an associated standard.

EXAMPLE

A statement like "capable of firing a missile and hitting a stationary target 10 miles away with an accuracy of ±5 feet," really describes two attributes (missile range and accuracy) whereas a statement such as "capable of firing a missile at altitudes greater than 20,000 ft describes a single attribute (firing altitude). Note: A system attribute is a characteristic of the system. The attributes above (missile range, accuracy, firing altitude) are all system attributes. They may also relate to tasks that the system enables. For example, standoff range and accuracy may be attributes of the "engage target" task for a SoS performing close air support. The third attribute, firing altitude may not relate directly to a task. It is based on a condition of the environment.

System/SoS Attributes and Task Attributes

Once relevant system attributes are identified, they must be matched to related tasks and sub-tasks. Successful task/sub-task accomplishment, and by extension, mission accomplishment, can be tied to attributes required of the system and other systems supporting the mission. Similarly, the favorable resolution of system suitability can also be tied to the capability of the system to meet associated attribute standards. In practice, system attributes may share a common dimension with the related task/sub-task attributes (e.g. system speed will probably be related to task performance timeliness). Thus allocating system attributes to related tasks and sub-tasks may be a simple exercise of identifying attribute relationships. While the CDD may explicitly relate some of the system attributes to specific tasks or sub-tasks, this will likely be the exception rather than the rule. In reality, most of these linkages will have to be determined based on system-task attribute comparisons and operational experience. While this process may be time consuming, these linkages are absolutely essential to the direct traceability between system function, task performance, and mission effectiveness.

In a typical CDD, there may be a significant number of required operational capability attributes listed. Many "attributes" will actually be complex requirements that include a system function, an operational task and conditions along with specific threshold and objective standards. There may also be some highly technical attributes which may not tie directly to tasks or sub-tasks. These highly technical attributes (e.g., transmission line loss for a RADAR system), while important to the program, may provide little in the way of operational insight to task accomplishment or system suitability and are often not operationally measureable. As such, the data collection, measurement, and analysis for these attributes will likely be accomplished as part developmental testing. These attributes may not necessarily be mapped to tasks/sub-tasks.

System/SoS Measures

Measures should easily be developed from system/SoS attributes, given the threshold and objective values have already been determined. In this case, the scale and quantitative criteria of the measure are already determined. What remains is a description of the measure and any qualifying conditions. If the threshold and objective values do not exist, then the measures may need to be developed from other system standards. It is possible that more than one measure may exist for an attribute. If so, then one measure will be the primary measure and any additional measures will be secondary to it.

EXAMPLE

In the previous example, the missile was identified to have attributes of missile range and accuracy. The missile range attribute with threshold value of 10 miles may be stated as a measure: Range of missile against a stationary target. Since "stationary" is a condition of the target and does not affect the missile range, the measure could be simplified as: Range of missile. The missile accuracy attribute with threshold value of ±5 feet may be stated as a measure: Distance from missile impact and stationary target. In this case, measure is dependent on the stationary condition of the target and must be included in the measure statement. A separate measure may exist for moving targets with a different threshold value.

Step 3: System/SoS Decomposition

Overview

Figure 4-1 shows the basic elements for decomposing system and SoS functions into attributes and measures. The process also includes mapping of system/SoS attributes to tasks and sub-tasks. This construct aligns with the JCIDS CBA and AoA processes that identify and categorize capability attributes into KPPs, KSA, and other attributes necessary to provide a capability. It establishes the connectivity of system and SoS functional capabilities to task performance and mission effectiveness.

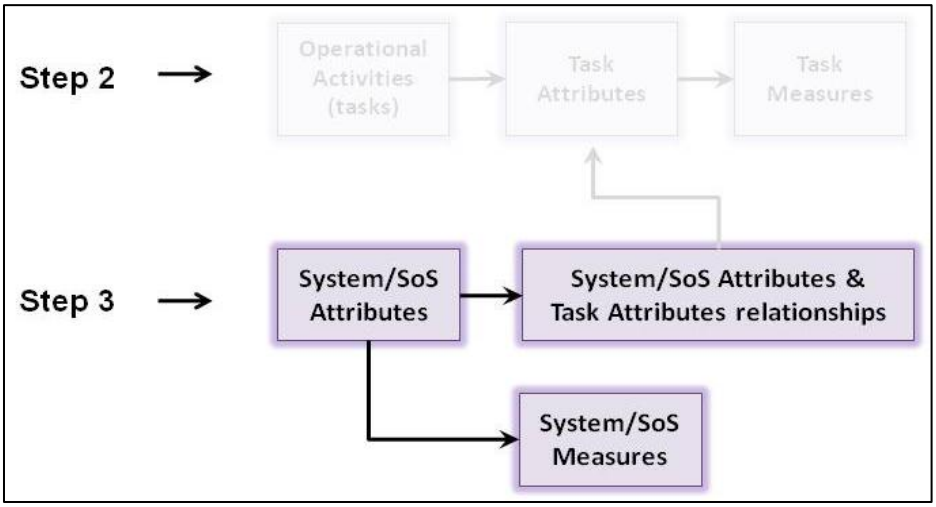

Figure 4-1. System/SoS Decomposition Flow

Element Descriptions

System. A system is a functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements; that group of elements forming a unified whole.[22] In the general sense, a system is an assemblage of components – machine, human – that accomplish a function. It is composed of material and non-material aspects across DOTMLPF that can be described by attributes.

- **System Under Test (SUT)**. A SUT is that material (machine) component of a system that is being tested for its ability to function in performing tasks. The SUT is the focus of an operational test within a SoS.
- **System-of-Systems (SoS)**. A SoS is a set or arrangement of interdependent systems that are related or connected to provide a given capability. The loss of any part of the system could significantly degrade the performance or capabilities of the whole.
- **System/SoS Attributes**. A system attribute describes a functional specification of a system in quantitative or qualitative terms. At the SoS level, the attributes are focused on a common characteristic across more than one system. System/SoS attributes can be in the form of KPPs, KSAs, or other system attributes.

- **Key Performance Parameters (KPP)**. A KPP is an attribute or characteristic of a system that are considered critical or essential to the development of an effective military capability.[23] KPPs are included in the CDD as testable attributes to enable feedback from test and evaluation efforts to the requirements process.
- **Key System Attributes (KSA)**. KSAs are still considered critical or essential attributes of an effective military capability, but were not selected as KPPs. KSAs should also be included in the CDD as testable attributes.
- **Other System Attributes (OSA)**. Other system attributes are important attributes that are not categorized as KPPs or KSAs.

- **System/SoS Measures**. System/SoS measures are used to assess system or SoS functionality in terms of system/SoS attributes. They measure technical parameters and design specifications of the system or SoS. Measures are typically quantitative and can be very detailed. System/SoS measures may be related to task measures of performance.

Process

The Step 3 process involves identifying system and SoS attributes from the JCIDS CDD and other authoritative documents, developing measures for these attributes, and mapping the system/SoS attributes to task attributes. The latter provides traceability of system and SoS material and non-material attribute impacts on task performance. Figure 4-2 illustrates that this process may be executed through the development of two matrices. Each matrix is intended simply to map relationships between the rows and columns.

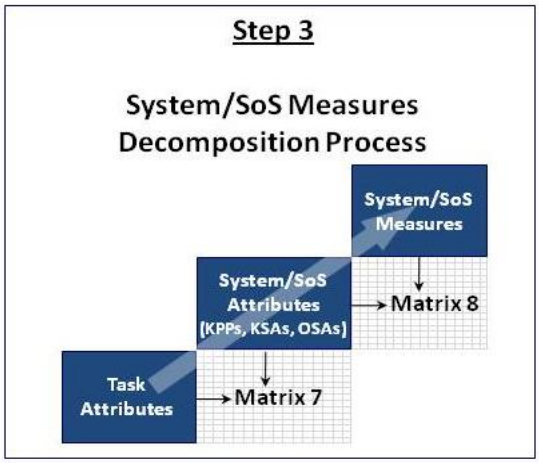

Figure 4-2. System/SoS Measures Decomposition Process

Matrix 7: System/SoS Attributes – Task Attributes

Matrix 7 begins Step 3 by mapping system/SoS attributes to task attributes. Some relationships may be derived from the CDD and any other previous analysis of capability requirements. Guidelines for mapping system/SoS attributes to task attributes are provided in the following callout box. Matrix 7 sample format is illustrated in figure 4-3.

General Guidelines for Determining Matrix 7 Relationships

- Use capability relationships documented in the CDD.
- Look for common types of system and task attributes (ex. speed of a system may be related to time to perform a task).
- Not all system/SoS attributes will map to task attributes.
- Some system/SoS attributes will be based on suitability requirements.
- Mapping can be a many-to-many relationship (i.e. system/SoS attribute can be mapped to many task attributes and vice-versa).
- If a task attribute does not have at least one system/SoS attribute mapped to it, then either additional system/SoS attributes need to be identified or the task attribute may not need to be evaluated as a part of the SUT.

System/SoS Attributes	Task 1- Attribute A	Task 1- Attribute B	Task 2- Attribute A	Task 2- Attribute B	Task 2- Attribute C
Attribute 1	X	X			
Attribute 2	X		X		
Attribute 3		X			
Attribute 4				X	X

Figure 4-3. Matrix 7 Example Format

Matrix 8: System/SoS Attributes – Measures

The development of this matrix should be fairly simple given there exists a CDD with attribute tables. Since attributes are based on functional characteristics of the system/SoS (i.e. speed, range, resolution, etc), the measures should assess those characteristics. If the attribute is sensitive to conditions of the environment, then the measure(s) may include conditional descriptors.

Most system/SoS measures will be quantitative, having a numerical value that can be measured. However, it is possible that a system/SoS may be qualitative and/or a binary "yes/no" type

measure. For example, a system attribute may be "readability". It is desired that an instrument panel be readable in a dark space. This may require a qualitative evaluation by operational users to determine "yes, it is readable" or "no, it is not readable". Recall a measure consists of a scale and a description. In this example, the scale is "yes/no" and the description is "Instrument panel is readable in a dark space". Note that "dark" is a condition of the environment in which the instrument will be used. Matrix 8 (figure 4-4) follows a simple format of attributes and measures as rows and columns respectively with relationships mapped.

General Guidelines for Determining Matrix 8 Relationships

- There should be at least one measure for each attribute.
- The same attribute may exist for a single system and the SoS. The measure may be the same, but the threshold values may differ.
- Measures may include conditions of the environment which can impact the measured value.

	Measure		Condition	
Attribute	Scale	Description	Description	Descriptor
Readable	Yes/No	Instrument readable	In an enclosed space	dark
	Yes/No	Instrument readable	In an enclosed space	lighted
Range	nm	Missile max range	A/C launch altitude	@10000ft
	nm	Missile max range	A/C launch altitude	@5000ft

Figure 4-4. Matrix 8 Example Format

Step 3: EXAMPLE

This section provides an example of the Step 3 process using the JPR JMT. This example will use a notional personal locator beacon (PLB) as the SUT. This handheld PLB is a rugged, multi-purpose survival radio and locator device for military aircrews, mariners, and ground personnel. Transmissions from this PLB are Omni-directional and continue for at least 24 hours at temperature extremes down to -20°C (Class 2) to help facilitate detection by satellite, aircraft or vessels, or by any other land, sea or airborne installations monitoring these frequencies.

Additional features (notional) include:

- Multi-emergency band – 121.5 MHz, 243.0 MHz and 406 MHz
- Two-way VHF or UHF voice communication (programmable)
- Remote activation of voice reception through a 1kHz pilot tone to address the user
- Fully self-contained (Transceiver, V/UHF/C-S antennas, with latest Generation 12-channel GPS)
- Compact, lightweight, with state-of-the-art technology
- Manual or automatic activation by lanyard or water immersion
- Extensive battery life
- Life vest and ejection seat capability
- Watertight to 10 meters (33 ft)
- Initiated built-in-test
- Compliance with: STANAG 7007 P 1 PSAR, MIL-STD 810E, ED-14E (DO-160E)

When activated, the device transmits sweep tone radio distress signals on the international VHF/UHF emergency frequencies, simultaneously sending messages on the COSPAS-SARSAT (CIS) satellite frequency, providing detection and accurate positioning anywhere in the world. Two way voice communications with SAR crews is utilized through VHF or UHF aviation and marine emergency frequencies mode that also aids in locating the user. This feature can be manually or remotely activated when the unit is operating in beacon mode. A simple built-in-test (BIT) function ensures quick and easy operational readiness of the unit and is self contained with a waterproof to a depth of 10 meters and battery shelf life of over five years.

This SUT is intended to replace existing PLBs to provide a more reliable, versatile, and lightweight PLB that can be carried by pilots into combat environments. Based on this information, the example CDD provides the system attribute information shown in table 4-1.

Table 4-1. SUT Attributes (Notional)

JCA	KPP	KPP Attribute	Threshold	Objective
C2	Operational Capability	Signal range	50 NM range	100 NM range
C2	Net-Ready	Interoperable	Interoperable with 100% U.S. SAR systems	Interoperable with 100% U.S. & coalition SAR systems
JCA	**KSA**	**KSA Attribute**	**Threshold**	**Objective**
Force protection	Protection	Transmitted data accuracy	99% data accuracy	Same as threshold
Force protection	Protection	Access and control	Single hand controllable	Same as threshold
Logistics	Sustainment	Reliability	95% probability operational for 24 hr period	99% probability operational for 24 hr period
Logistics	Sustainment	Ownership cost	$50 annual upkeep cost	$25 annual upkeep cost
C2	Interoperability	Transmission output	20 watt continuous power	25 watt continuous power
		Other System Attributes	**Threshold**	**Objective**
		Shock resistant	Withstand ejection seat shock	Same as threshold
		Speed of initial report	5 sec after activation	2 sec after activation
		Water resistant	Watertight to 5m	Watertight to 10m
		Battery life	5 year	7 year

Matrix 7 Example: System/SoS Attributes – Task Attributes

Matrix 7 involves the mapping of system/SoS attributes to task attributes. Following the general guidance for developing matrix 7, the mapping can be used to trace the relationship of system/SoS attributes to task performance. Note that since task performance is a component of mission effectiveness, those system/SoS attributes for suitability may not map to task attributes. Figure 4-5 provides an example matrix 7 based on the table 4-1 attributes.

Task		Locate										
Sub-task		Execute search plan			Verify & fuse location			Authenti-cate IP		Share location		
System/SoS Attribute	Task Attribute	Accuracy	Timeliness	Info Reliability	Accuracy	Timeliness	Info Reliability	Accuracy	Completeness	Accuracy	Timeliness	Completeness
Type / Attribute												
KPP Operational Capability: Signal range				X			X					
KPP Net-Ready: Interoperable		X	X	X	X	X	X	X	X			
KSA Protection: Transmitted data accuracy		X		X	X		X	X				
KSA Protection: Access and control									X			
KSA Sustainment: Reliability				X			X		X			
KSA Sustainment: Ownership cost												
KSA Interoperability: Transmission output		X	X		X	X						
OSA Shock resistant												
OSA Speed of initial report			X			X						
OSA Water resistant												
OSA Battery life												

Figure 4-5. Matrix 7 Example – System/SoS Attributes & Task Attributes

Matrix 8 Example: System/SoS Attributes – Measures

Matrix 8 involves the determination of measures for the system/SoS attributes. It is suggested to start with measures for the KPPs, then KSAs, and then down to OSAs. This practice will help emphasize the relative importance of KPPs, KSAs, and OSAs. Most measures will probably be a direct statement of the attribute and its criteria (i.e. threshold and objective values). Other measures may require a little more thought on how to evaluate the system/SoS attribute. Consider any clarifying environmental conditions related to the measure. This will probably be included in capability statements within the CDD and their associated criteria. Include this condition information in matrix 8. Figure 4-6 provides an example matrix 8 based on the table 4-1 attributes.

System/SoS Attribute		System/SoS Attribute Measure		Conditions	
Type	Attribute	Scale	Measure Description	Condition	Descriptor
KPP	Operational capability: Signal range	NM	Max range for clear continous signal	Ambient temperature	-20C
		NM	Max range for clear continous signal	Ambient temperature	50C
KPP	Net-Ready: Interoperable	Pct	SAR systems interoperable with	Friendly forces	U.S. only
		Pct	SAR systems interoperable with	Friendly forces	U.S. and coalition
KSA	Protection: Transmitted data accuracy	Pct	Data transmissions that are complete		
		Pct	Data transmissions that are complete & accurate		
KSA	Protection: Access and control	Y/N	Single handed controllable operations		
KSA	Sustainment: Reliability	Pct	Probability operable for 24 hr period	Ambient temperature	-20C
		Pct	Probability operable for 24 hr period	Ambient temperature	50C
KSA	Sustainment: Ownership cost	$$$	Annual maintenance cost		
KSA	Interoperability: Transmission output	Watts	Continuous transmission power output	Ambient temperature	-20C
		Watts	Continuous transmission power output	Ambient temperature	50C
OSA	Shock resistant	Pct	Operable after ejected from aircraft seat		
OSA	Speed of initial report	Sec	Time between activation & initial beacon broadcast		
OSA	Water resistant	Meters	Max depth maintains watertight		
OSA	Battery life	Years	Max battery shelf life		

Figure 4-6. Matrix 8 Example: System/SoS Attributes & Measures

SUMMARY

In summary, system and SoS provide capabilities to perform tasks and achieve mission effectiveness. Identifying system/SoS attributes and measures enables linking those capability characteristics to task performance and mission effectiveness requirements. Those linkages provide the traceability needed to assess the "cause" of missing task and mission standards.

Task level measures enable a quantitative assessment of task performance. Task performance provides the basis for evaluating the warfighter's ability to accomplish the mission. Task measures account for interactions across systems and assess performance based on key attributes for each task.

Mission level measures provide an ability to assess mission effectiveness in terms of desired effects. Mission measures are based on attributes of those desired effects. Real-world operations may use these measures to gauge how well they are performing the mission. It may provide a baseline for determining future gaps and seams. The training, experimentation, and testing communities will benefit in being able to assess impacts on overall mission effectiveness. Note that critical operational issues may be used to qualitatively assess mission effects, when it is not feasible to collect sufficient quantitative data on mission level measures.

ANNEX A
ACRONYMS AND ABBREVIATIONS

ACRONYM OR ABBREVIATION	DEFINITION
AV	All Viewpoint
BCD	Battlefield Coordination Detachment
C2	Command and Control
CBA	Capabilities-Based Assessment
CCRP	Command and Control Research Program
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CJCSM	Chairman of the Joint Chiefs of Staff Manual
CONOPS	Concept of Operations
CTM	Capability Test Methodology
CTP	Critical Technical Parameter
DAU	Defense Acquisition University
DE	Desired Effect
DM2	Department of Defense Architecture Framework Version 2.0 Meta-Model
DoD	Department of Defense
DoDAF	Department of Defense Architecture Framework
DOT&E	Director, Operational Test and Evaluation
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
DPMO	Defense Prisoner of War/Missing Personnel Office
FM	Field Manual
IP	Isolated Personnel
ISOPREP	Isolated Personnel Report
J	Joint
JCA	Joint Capability Area
JCIDS	Joint Capabilities Integration and Development System
JMT	Joint Mission Thread
JMTAT	Joint Mission Thread Architecture and Test
JP	Joint Publication
JPR	Joint Personnel Recovery
JPRC	Joint Personnel Recovery Center
JROC	Joint Requirements Oversight Council
JT&E	Joint Test and Evaluation
JTEM	Joint Test and Evaluation Methodology
JTEM-T	Joint Test and Evaluation Methodology - Transition
KPP	Key Performance Parameter
KSA	Key System Attribute
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOS	Measure of Suitability

ACRONYM OR ABBREVIATION	DEFINITION
MWG	Metrics Working Group
NATO	North Atlantic Treaty Organization
OP	Operational
OV	Operational Viewpoint
PLB	Personal Locator Beacon
PR	Personnel Recovery
PRCC	Personnel Recovery Coordination Cell
QFD	Quality Function Deployment
SecDef	Secretary of Defense
SERE	Survival, Evasion, Resistance, and Escape
SITREP	Situation Report
SME	Subject Matter Expert
SoS	System-of-Systems
SUT	System Under Test
SV	Systems Viewpoint
SvcV	Services Viewpoint
SWarF	Senior Warfighters Forum
T&E	Test and Evaluation
TA	Tactical
TTP	Tactics, Techniques, and Procedures
UJTL	Universal Joint Task List
USJFCOM	United States Joint Forces Command
USMC	United States Marine Corps

ANNEX B
TERMS OF REFERENCE

The following terms of reference establish a lexicon for discussing Joint Mission Thread (JMT) measures development. Whenever possible, definitions were taken from authoritative joint publications.

Activity: An activity is work not specific to a single organization, weapon system, or individual that transforms inputs into outputs or changes their state. (Department of Defense Architecture Framework Version 2.0 [DoDAF 2.0])

Attribute: A quantitative or qualitative characteristic of an element or its actions. (*Manual for the Operation of the Joint Capabilities Integration and Development System* (JCIDS Manual), Revised July 31, 2009 [Chairman, Joint Chiefs of Staff Manual (CJCSM) 3170.01C Cancelled])

Capability: The ability to achieve a desired effect under specified standards and conditions through combinations of means and ways across doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) to perform a set of tasks to execute a specified course of action. (JCIDS Manual, Revised July 31, 2009)

Condition:
1. Those variables of an operational environment or situation in which a unit, system, or individual is expected to operate and may affect performance. (CJCSM 3500.04E, *Universal Joint Task List Manual* [UJTL Manual], August 25, 2008)
2. The sample of adversaries and operating conditions – the scenario. (*Capabilities-Based Assessment User's Guide*, Version 3, March 2009)

Criterion: The minimum acceptable level of performance associated with a particular measure of [task] performance. It is often expressed as hours, days, percent, occurrences, minutes, miles, or some other command-stated measure. (CJCSM 3500.04E, UJTL Manual, August 25, 2008)

Effect [Mission Desired]:
1. The physical or behavioral state of a system that results from an action, a set of actions, or another effect.
2. The result, outcome, or consequence of an action.
3. A change to a condition, behavior, or degree of freedom.
   (Joint Publication [JP] 1-02, *Department of Defense Dictionary of Military and Associated Terms*, April 12, 2001, as amended April 2010)

Function [System/Operational]: The action for which a person or thing is specially designed, fitted, used, or intended to accomplish or execute. (DoDAF 2.0)

Joint Mission Environment: A subset of the joint operational environment composed of force and non-force entities; conditions, circumstances, and influences within which forces employ capabilities to execute joint tasks to meet a specific mission objective. (JCIDS Manual, Revised July 31, 2009)

Joint Mission Thread: An operational and technical description of the end-to-end set of activities and systems that accomplish the execution of a joint mission. (CJCSI 6212.01E, *Interoperability and Supportability of Information Technology and National Security Systems*, December 2008)

KPP/KSA/CTP: Attributes/parameters of a system that are considered critical. (JCIDS Manual, Revised July 31, 2009)

Means:
1. Forces, units, equipment, and resources. (*Terms of Reference [TOR] for Conducting a Joint Capability Area (JCA) Baseline Reassessment*, April 9, 2007)
2. Solutions represent means, or resources that can be employed. (*Capabilities-Based Assessment User's Guide*, Version 3, March 2009)
3. Means are based on DOTMLPF organization, materiel, personnel, and facility resources.

Measure: A parameter that provides the basis for describing varying levels of task accomplishment. (CJCSM 3500.04E, UJTL Manual, August 2008)

Measure of Effectiveness: A criterion used to assess changes in system behavior, capability, or operational environment that is tied to measuring the attainment of an end state, achievement of an objective, or creation of an effect. (JP 1-02, April 12, 2001, as amended September 2010)

Measure of Performance: A criterion used to assess friendly actions that are tied to measuring task accomplishment. (JP 1-02, April 12, 2001, as amended September 2010)

Measure of Suitability: A measure of an item's ability to be supported in its intended operational environment. (Defense Acquisition University Glossary, 13th ed., Nov, 2009)

Measure of System/System of Systems (SoS) Attribute: A parameter that describes varying levels of attributes. (Capability Test Methodology Handbooks, April 2009)

Mission: The task, together with the purpose, that clearly indicates the action to be taken and the reason therefore. (JP 1-02, April 12, 2001, as amended September 2010)

Node: An element of a system that represents a person, place, or physical thing. (JP 1-02, April 12, 2001, as amended September 2010)

Standard: A standard provides a way of expressing the acceptable proficiency that a joint organization or force must perform under a specified set of conditions. A standard consists of one or more measures for a task and a criterion for each measure. (CJCSM 3500.04E, UJTL Manual, August 2008)

System: A functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements; that group of elements forming a unified whole. (JP 1-02, April 12, 2001, as amended September 2010)

System-of-Systems (SoS): A set or arrangement that results when independent and useful systems are integrated into a larger system that delivers unique capabilities. (JCIDS Manual, Revised July 31, 2009)

Task: An action or activity (derived from an analysis of the mission and concept of operations) assigned to an individual or organization to provide a capability. (CJCSM 3500.04E, UJTL Manual, August 2008) NOTE: This term and its definition are to be included in JP 1-02.

Ways:

1. Doctrine; tactics, techniques, and procedures;, competencies; and concepts. (*TOR for Conducting a JCA Baseline Reassessment*, April 9, 2007)
2. Functions [are] considered ways. (*Capabilities-Based Assessment User's Guide*, Version 3, March 2009)
3. Ways are based on DOTMLPF doctrine, training, and leadership.

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ANNEX C
ENDNOTES

[1] *Manual for the Operation of the Joint Capabilities Integration and Development System* (JCIDS Manual), Revised July 31, 2009, page GL-19.
[2] Kass, Richard A., *The Logic of Warfighting Experiments*, Command and Control Research Program (CCRP), August 2006.
[3] Department of Defense Architecture Framework (DoDAF) Version 2.0 (DoDAF 2.0), Volume I, pages 77-79.
[4] http://en.wikipedia.org/wiki/Reed-Kellogg_sentence_diagram.
[5] JCIDS Manual, Enclosure B, Revised July 31, 2009.
[6] JCIDS Manual, Appendix A, Enclosure A, Revised July 31, 2009.
[7] Ibid.
[8] Chairman, Joint Chiefs of Staff Manual (CJCSM) 3500.04E, *Universal Joint Task List Manual* (UJTL Manual), August 25, 2008, Page B-B-4.
[9] Ibid.
[10] Director, Operational Test and Evaluation (DOT&E) Memorandum, "Reporting of Operational Test and Evaluation (OT&E) Results," January 6, 2010.
[11] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Terms and Abbreviations*, April 12, 2001, as amended April 2010.
[12] CJCSM 3500.04E, UJTL Manual, August 25, 2008, Page C-1.
[13] http://en.wikipedia.org/wiki/Quality_function_deployment.
[14] The term "system" in JP 5-0, *Joint Operation Planning*, uses this concept from JP 3-0, *Joint Operations*: A system is a functionally related group of elements forming a complex whole. A systems perspective of the operational environment strives to provide an understanding of interrelated systems (for example, political, military, economic, social, information, infrastructure, and others) relevant to a specific joint operation without regard to geographic boundaries. (JP 3-0, *Joint Operations*, with Change 2, March 22, 2010, Page II-23) This use of the term "system" is more generalized and should not be confused with the more functionally oriented definition found in the *Defense Acquisition University (DAU) Glossary of Defense Acquisition Acronyms and Terms* (DAU Glossary), 13th Edition, November 2009.
[15] JP 1-02, April 12, 2001, as amended April 2010.
[16] CJCSI 3170.01 (Series), March 2009, Page GL-3.
[17] DoDAF 2.0, Volume II, Annex 2, Table 3.1.1-1, May 28, 2009.
[18] DoDAF 2.0, Volume II, Table 3.1.1-1.
[19] Joint Mission Thread Tier 1 Document, January 21, 2010, Page 82.
[20] DAU Glossary, 13th Edition, November 2009.
[21] JCIDS Manual, Enclosure B, Page B-2, Revised July 31, 2009.
[22] JP 1-02, April 12, 2001, as amended April 2010.
[23] CJCSI 3170.01 (Series), March 2009, Page GL-7.